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THE SNOW BOOK

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The snow book

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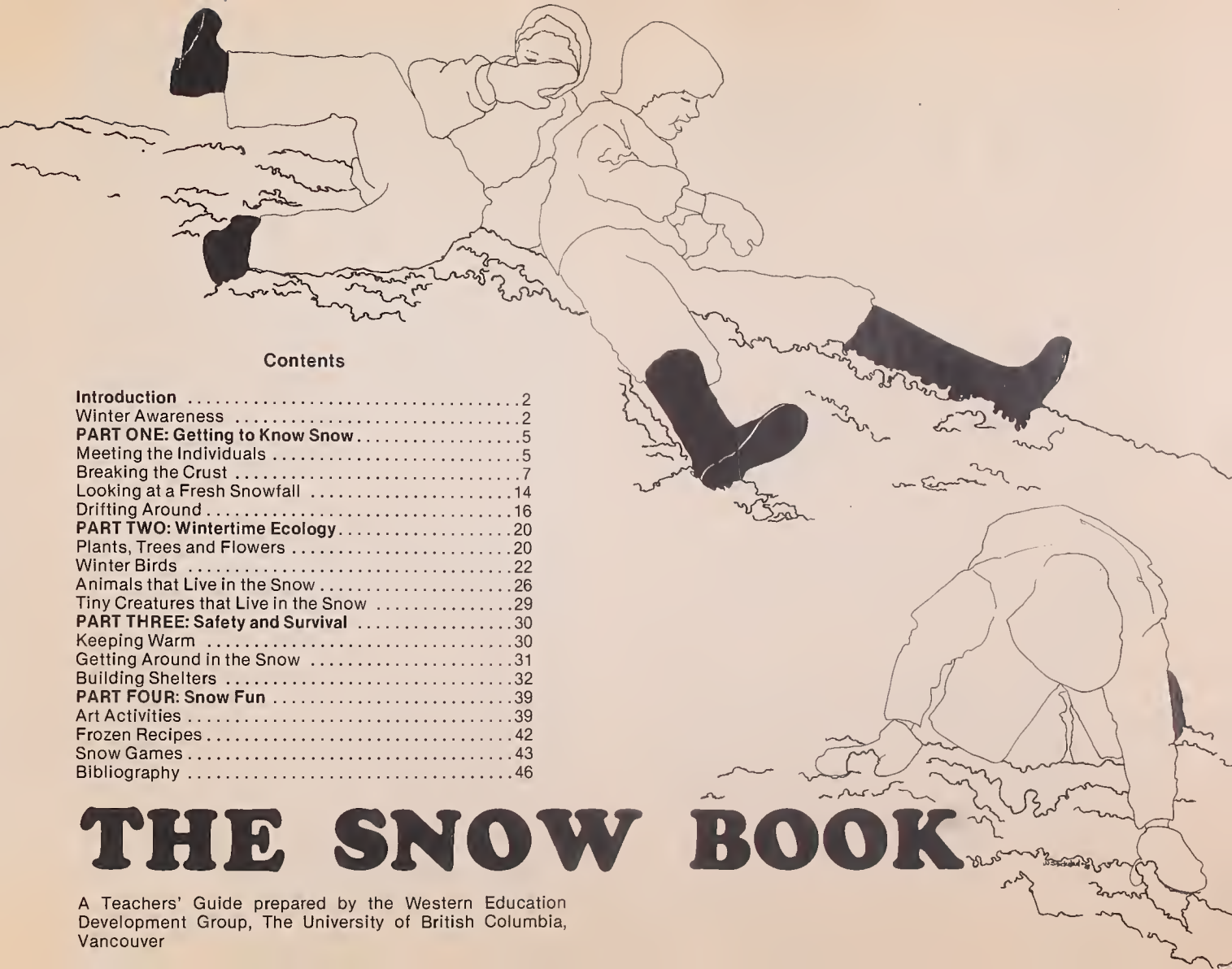

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THE SNOW BOOK

A Teachers' Guide prepared by the Western Education Development Group, The University of British Columbia, Vancouver

Objectives

Winter is a very special time of year for children's experiences. What children learn during their natural interactions and explorations with snow is difficult to define. This book, however, seeks to develop a number of specific outcomes. These objectives have been developed to assist those who supervise snow activities to predict the growth of children's understanding.

Children who have experienced the activities outlined in this book should be able to:

1. Describe the taste, odour and feel of new fallen and old snow.
2. Catch a falling snowflake and make an imprint of it.
3. Identify the basic shapes of snow flakes.
4. Show you how to measure the snow's depth, temperature, density and hardness.
5. Show you how to test for pollution in the snow.
6. Describe how trees can be identified in winter.
7. Tell you what red snow tastes like.
8. Build a winter bird feeder and tell you how to go about observing the birds which come to feed.
9. Show you how to study winter tracks and how to make plaster casts of them.
10. Take a winter wildlife census.
11. Build a pair of workable snowshoes.
12. Build snow shelters which can be slept in.
13. Tell you what you need to survive when lost in winter.
14. Create many different kinds of winter works of art.
15. Show you how to play snow games.

Introduction

Every winter children spend a great deal of their time in and around snow. The first snowfall of each winter season is always greeted with a special enthusiasm, sparked by memories of past experiences and anticipation of the pleasures to come. Most children, however, plough through the season's snowfall without understanding its basic properties. This book is meant to provide the classroom teacher with an abundance of enjoyable and interesting wintertime activities — activities which will not only introduce the students to the physical properties of snow and to the various facets of the winter ecology, but will also make clear the relationship between the two.

It is hoped that the students will develop a fund of personal knowledge about the snow environment and thus become enthusiastic participants and sensitive observers of their frozen surroundings. To this end, we have started the book off with a number of "winter awareness" activities. Also included is a section concerned with winter survival. We hope this will help both teacher and student become safety minded, and thus more confident in a potentially dangerous environment. The fun activities are a collection of snow-related ideas and games that could be included at any point in your snow study. They are meant to enhance the learning situation by providing enjoyment while educating children about their environment.

Above all, the book is concerned with having the children try out activities which are linked to real-life situations. Most of the "Getting to Know Snow" activities are adapted from actual exercises performed by government teams of snow surveyors. These teams set out each winter to measure the depth and water equivalent of the snow at many locations throughout the mountains of the province. Using the information they collect, it is possible to predict the amount of water which will run off the mountain when the snow melts in the spring. This gives us the advantage of being able to prepare for floods or droughts before they occur. By having the children perform some of these activities it is hoped that they will become aware of the importance of learning about snow.

No snow flake is the same as any other. In the same way, no snow cover is the same as any other. With this in mind, we have designed the activities to be adaptable to any of the endless possible variations in snow cover that can be expected in our climate.

Winter Awareness

A good way to begin snow studies is to help the students become acclimatized to the winter environment. The following sensory-based activities are designed to increase the children's awareness of the beautiful and delicate environment of winter. By trying them out, the students will be able to take a closer, more appreciative look at the natural wonder that is snow. The following exercises are intended to get both student and teacher neck deep in participation and are ideally suited for making use of the spontaneous joy of the season's first snowfall. We have only two bits of advice; have fun and be prepared to get wet!

Observing the snow

Pick up a handful of snow and look closely at the flakes.

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What shapes are the crystals? Can you describe the texture of your handful of snow? Can you find different textures and crystal shapes in the snow? Look closely while you compress a handful of snow into a snowball. What happens to the crystals? See if you can find different types of snowflakes in the surrounding area. Try looking in snowdrifts and in trees for different snow types. Dig down to the ground underneath the snow cover. What does this ground look like? Have any changes occurred since the snow fall?

Feeling the snow

Take off your gloves and feel the snow. Run it through your fingers and experience its tingly coldness on your cheeks. Get right into the snow. Try walking on your knees in the deep snow. Roll around in it and feel whether it is wet, dry or somewhere in between. Bury yourself completely. Can you get comfortable underneath the snow? Is it warmer above or beneath the snow? Can you breathe easily when your face is buried in the snow? Try making some shapes in the snow with your body.

Tasting and smelling the snow

Pick a spot where the snow is white and clean. Take a handful and put some on your tongue. Can you describe the taste? What does it feel like when you let the snow slowly melt on your tongue? Try tasting some fresh snow from the top layer of snowfall. Now dig down deep and taste the snow from the bottom of the snowdrift. Is there any difference in the taste or in the smell? Can you describe the smell of the snow in the air or on the ground?

Walking blind in the snow

Have all the students choose partners and give each pair a blindfold. After having placed the blindfold over a partner's eyes, each student will lead his partner on a closely guarded walk through the snow.

Give your partner something to feel; something to taste; something to listen to. Ask him to pick out any new sounds he hasn't heard before. Ask him to pick out as many sounds as possible. Have him listen to the sounds you both make as you crunch through the snow. Stay absolutely quiet for a while and see what happens. Now change blindfolds to the other partners and repeat the activity.

Just for fun

Roll a huge snowball, using everyone in the class to push it. Turn this snowball into a magnificent sculpture or even a fort. What kind of snow packs best? Why do you think this is so? Roll several balls together to make a snowfort. Have a snowball fight and protect your snowfort. Build a snowman, snowlady, or even a snowmonster. Create your own games to play in the snow.

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PART ONE

Getting To Know Snow

Every student should have an opportunity to become familiar with the basic physical properties of snow. After trying the activities in this section, the students may get to know not only some characteristics of individual snow crystals, but also the many ideas about different types of snow cover.

Before trying out any of the activities, it is highly recommended that the teacher introduce a study of snow surveyors and their work. Up to date snow survey bulletins are available from your provincial government.* The bulletins include the latest information on snow depth and conditions. The authors also make general predictions as to the expected run-off from the melting snow cover. Another good reference is C.B. Colby's *Snow Surveyors***. This beautifully illustrated book covers the topic in a non-technical and interesting manner, making it an excellent resource book for the intermediate grades.

Having made a study of actual snow surveyors, the students will begin to see the importance of understanding snow and snow cover. Thus, they will be more interested and ready to tackle the experiments with the knowledge that what they are doing has real meaning.

Meeting The Individuals

When carrying out a study of snow and snow cover, it makes sense to have the students start by taking a close look at individual snow-flakes. They will be surprised and delighted to discover the beauty and uniqueness of each individual crystal.

All materials used in the observation of crystals should be stored in a freezer or out of doors if below freezing level. This will help to keep the samples from melting too rapidly.

Catching Snowflakes

The best way to have your students observe snowflakes first hand is to let them catch their own. Here are three methods:

Each student will need: a 15 cm square of black velvet or dark paper covering a piece of cardboard and a hand lens

Since this sample is taken when the snow is actually falling, it is called a "storm sample". It is the best way to collect undamaged flakes, as they have usually not been broken by hitting the ground.

Have the students hold their pieces of cardboard out into the snow to collect a random sample of snowflakes. The apparatus should be exposed between 1 and 10 s depending on the intensity of the snowfall. They should now put this under cover and use a hand lens to observe the numbers and types of snowflakes caught. The white snowflakes are easy to observe in detail against the black velvet.

While looking at their samples, students may wish to try the following:

— Sketch two snowflakes which are similar in structure.
— Sketch two snowflakes which are totally different in structure.
— Measure several snowflakes and record the range in size.
— Sketch a broken snowflake.

Students may make additional sketches of the snowflakes they have caught and these can be compared with the "Types of Snowflakes" chart provided. In this way, the snowflakes they have observed can be identified and recorded.

Collecting A Fallen Snow Sample

It is not always possible to be on hand when snow is actually falling. A fairly good sample can still be collected, however, from snowflakes which have already fallen.

You will need:

— a cold trowel or sharp edged flat tool
— a piece of cardboard with black velvet as described in the previous activity
— a snowflake identification chart

* In B.C., the Hydrology Division, Water Investigations Branch, Ministry of Environment, Parliament Buildings, Victoria, B.C. V8V 1X5

** Colby, C.B. *Snow Surveyors. Defenders Against Flood and Drought,* Coward-McCann, Inc., New York, 1959.

— a clipboard for each student
— materials to make a snowflake size gauge for each student
— a hand lens for each student

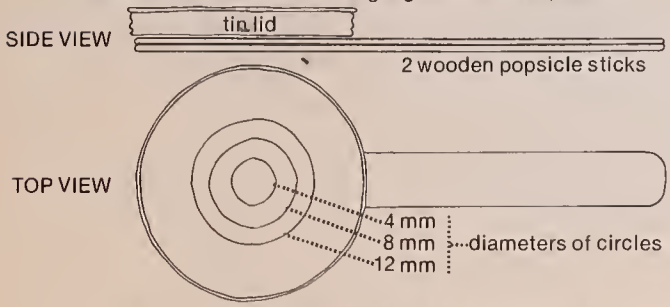
Have the students scoop up a sample of snow with the trowel. With a quick swing, throw the snow sample into the air so that part of it falls on the black velvet.

This method is effective within about 24 h of the last snowfall. After this time, however, the snow crystals begin to show signs of age and no longer retain their original structure.

Here is another way to collect and measure snowflakes.

For this activity the students will first need to build their own snowflake size gauges. Each student will need two popsicle sticks and a jar lid about 4 cm in diameter and 1 cm deep.

Glue the popsicle sticks together, one directly on top of the other. You will now have a stick of double-thickness that will serve as a non-heat conducting handle. Spray the inside of the jar lid with any colour of flat spray paint, except black. (Black absorbs too much heat if it is sunny.) Scratch five concentric circles in the bottom of the lid with a sharp point. These should increase by a distance of 4 mm per line. Using epoxy glue, attach the lid to the end of the popsicle stick handle. Your snowflake size gauge is now complete.



After cooling the gauge by either placing it in the freezer or outside in the cold, the kids can begin to collect their snowflakes. When a suitable flake is caught on the gauge, it should be held under cover and examined with a hand lens. The students should now be able to record the size of each flake using the 4 mm rings as a guide. They should also be able to classify their flakes by using the table provided. Some students may wish to draw diagrams of their crystals.

How to Make Snowflake Fossils

Making snowflake fossils can provide the class with an excellent opportunity to take an in depth look at the various crystal shapes and their intricate patterns. For their permanent records, students may wish to single out only the perfect crystals. The following procedures can provide a permanent collection of snowflake impressions.

Making a fossil of a storm sample

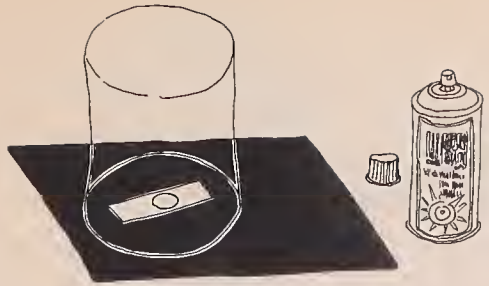
You will need:
— several microscope slides for each student
— a piece of corrugated cardboard 15 × 15 cm for each student
— cans of clear lacquer spray
— glass jars or beakers

Keep the above materials in the freezer. When the activity is about to begin, quickly move the material outside. Avoid touching the glass slides since they heat up very rapidly.

1. Place a slide on the cardboard.
2. Spray a thick layer of clear lacquer on the slide.
3. Let several snowflakes fall on the sprayed slide.
4. When several good samples have been collected, place cold glass beakers or jars over the slides to prevent further snow from falling on them.
5. Allow the lacquer to dry for 2 h in the cold.
6. The snowflakes will leave imprints as the lacquer dries and the children will have permanent snowflake fossils.

Making a fossil of a single flake

You will need:
— black velvet
— pieces of corrugated cardboard about 15 × 15 cm
— glass jar of 1% solution of Formvar 15—95, dissolved in ethylene dichloride or chloroform having a temperature of —5°C.
— sharp pointed rod (can be a wooden toothpick)
— microscope slides



— whisk broom
— some glass jar or beakers.

1. Stretch the piece of velvet over the cardboard.
2. Place the cold solution in a protected area with the cover removed.
3. Lower a toothpick or rod several cm into the solution.
4. Quickly withdraw the rod, to allow a drop of solution to drain to the end of the toothpick.
5. Touch the surface of the microscope slide with the drop. (The drop will stay on the slide several minutes before it evaporates.)
6. Hold out the sheet of velvet in the falling snow for several seconds.
7. Quickly scan the crystal samples, and if a perfect one is not to be found, brush the velvet with the whisk broom. Try again.
8. When a satisfactory crystal is found, touch the still moist toothpick to the crystal and it will stick.
9. Quickly touch the adhered crystal to the drop of liquid on the slide.
10. The crystal will sink into the solution. The liquid tends to creep all over the crystal, even the parts projecting above the surface.
11. Place a glass jar or beaker over the sample. The longer the sample is kept cold the better, for melting water may cause the collapse of some of the finer detail.

When they are dried, examine the snowflake prints under a microscope (40 or 50 power). Make diagrams of the prints and compare them to the frozen precipitation chart. How many different types of snow crystals were found?

Make sure all slides are labelled including snowflake type, date and time collected, temperature when collected, location, wind speed, weather conditions or any other data you feel is pertinent.

If it is not possible to collect a sample while the snow is falling, use the procedure described for collecting a fallen snow sample. That is, a sample of snow is scooped up with cold trowel and thrown into the air so that some of the snowflakes fall on the slides. Remember, the sample must be taken within 24 h of the last snowfall so that the crystals will retain their original condition.

Observing the aging of snowflakes

Every snowflake changes as it ages. This is caused mainly by heat from the ground or sun. As the crystals warm, the more delicate parts evaporate and recondense on to the snowflake in the form of ice, changing the flake to a granular composition. Since this process is fairly predictable, you can roughly determine the age of the snow by the shape of the flakes, i.e. the more granular the flake, the older the snow. In the late spring the snow is so granular skiers call it corn snow.

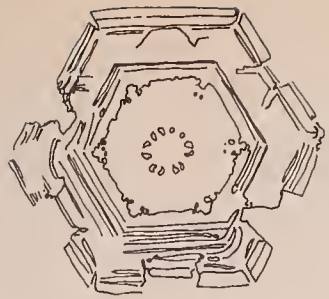
Students may want to keep a permanent record of the aging of snow by taking samples from different layers in a snow drift. This can be done by making lacquer prints of fallen snow as explained in the previous experiments.

The age can be determined by referring to the diagrams given by LaChapelle in his study of *Destructive Metamorphosis of Snow Crystals**. His book illustrates the process of metamorphosis over a period of 57 d.

Breaking the crust

Once the children have become acquainted with individual snowflakes, they will be better equipped to understand the characteristics of snow and snow cover in general. In this section, they will be dealing with such concepts as detecting different snow layers in a drift and measuring snow layer thickness, density, mass and temperature.

* La Chapelle, Edward R. *A Field Guide to Snow Crystals*, University of Washington Press, Seattle, 1969.



FOR YOUR INFORMATION

Frost, rime, glaze, sleet and hail are all relatives of the snowflake. Although they belong to the same family, each one is quite different.

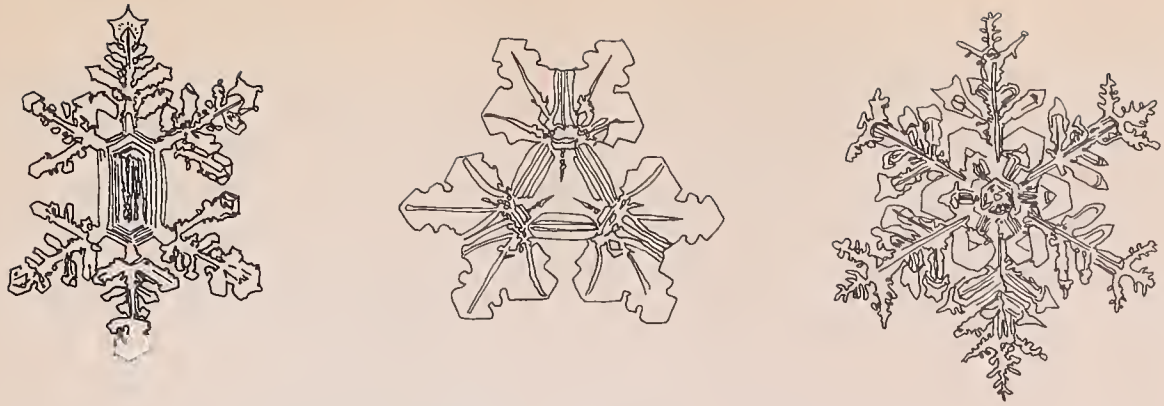
Frost: contrary to common belief, frost is not frozen dew. It is the result of water vapour in the air condensing into ice which forms crystals on cold objects outside.

Rime: rime is formed when water droplets in clouds or fog, blown by the wind, come in contact with an extremely cold object (i.e. tree, building, wing of an airplane). These tiny droplets instantly freeze to solid ice and cluster together like small white pearls.

Glaze: glaze is formed when there is a layer of sub-freezing air near the ground with warm clouds above it. When rain falls from the clouds, it freezes as it comes in contact with very cold objects. The objects are then coated with slippery, clear ice. Glaze is often called *freezing rain.*

Sleet: sleet is made up of frozen raindrops. It's formation is very similar to glaze, but for sleet to form, the layer of sub-freezing air close to the ground must be several thousand feet thick, instead of several hundred. Ice forms as a shell around a raindrop and then freezing progresses towards centre of the drop. Because the water at the centre of the droplet turns to ice, expansion pushes the shell out into odd shapes, causing irregular ice pellets. A mixture of rain and snow is also often called sleet.

Hail: hail is formed in cumulus clouds called thunderheads. Raindrops are swept up to high sub-freezing altitudes in thunderheads by strong updrafts of air. The raindrops are converted to pellets of ice and may be caught and swept up again by fierce updrafts of air. This process may occur several times over, each time forming another layer of ice. Hailstones can be the largest form of precipitation, ranging in size from 2 mm in diameter to 10 or 12 cm.



Types of Snowflakes

Symbol	Name	Snow and Ice Crystals
⬡	Hexagonal Plates	
✳	Stellar Crystals	
▭	Hexagonal Columns	
⟷	Needles	
✳	Spatial Dendrites	

Symbol	Name	Snow and Ice Crystals
▭	Capped Columns	
⌒	Irregular Crystals	
⧖	Graupel	
△•	Sleet	
▲	Hail	

Setting up a snow station

The snow stations are centers where students can carry out most of the experiments to follow. It is suggested that they be built in unfrequented areas so that they will not need constant repair.

So that the students may compare and contrast the data they collect, the stations should be set up in two different areas:

1. In an open environment (playing fields, meadows, etc.)
2. In a sheltered environment (in groves of trees, between buildings, etc.)

Have the students dig a square hole in a snowdrift until ground level is reached. Ideally this hole should be big enough for four or five students to work in. The students should be encouraged not to trample the area, so that the snow layers can be observed in their most natural state.

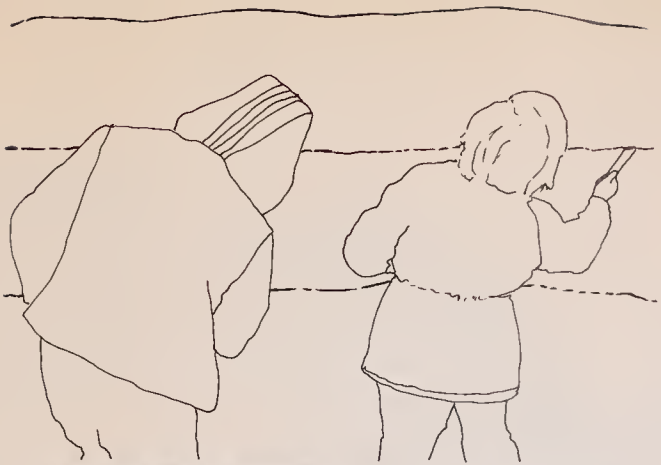
When the stations have been built, you may wish to have each group carry out all its experiments in the station built by that group. As an alternative, you can allow them to work freely at the different stations.

Measuring the snow layers

You will need:
- a clipboard for each student
- metre sticks
- hand lenses

After having prepared a snow station, the children should be encouraged to try and pick out the separate layers of snow which have been formed by past snowfalls. There are several exercises that can be tried when studying the snow layers:

1. Use your metre stick to measure the overall depth of the snow.
2. Pick out and count the separate layers of snow in your cross-section. How many past snowfalls can you count?
3. Take crystal samples of each layer and observe them with your hand lens.
4. How do snowflakes from the top layers differ from the snowflakes on the bottom layers?
5. What differences can you find between the younger and older flakes?
6. Try making a snowball from each of the different layers. What is the relationship between the age of the snow



and its packing qualities?

7. Measure and record the depth of each separate layer.
8. In class, make a display or chart which compares the information taken from different snow stations.

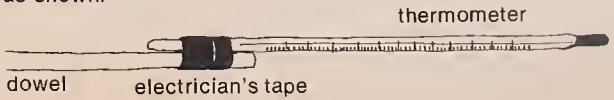
Taking the snow's temperature

One of the most important aspects of snow cover is its ability to insulate. This insulation becomes very effective once the cover has reached a depth of 15 cm or more. At this point, heat which radiates from the ground is trapped and held fairly constant underneath the blanket of snow. This insulation enables a host of small animals to survive the winter by taking refuge below the snow layer.

When taking the snow's temperature, the children may be surprised to discover the wide difference in temperature between the snow layers.

You will need: thermometers
40 cm lengths of 1 cm dowel
clipboards
electrician's tape

Tape the top of the thermometer to the end of the dowel as shown.



After picking out the major layers of snow, push the thermometer about 40 cm into the lowest layer and leave it there for approximately 2 min. Now, pull the thermometer out and quickly take a reading. Record your finding. Repeat this procedure for each layer of snow, working from the bottom up. Take an air temperature reading 1 cm above the snow. Take your final reading at about 1 or 2 m above the snow cover. Record all temperatures so that you may compare your data with that taken from other snow stations.

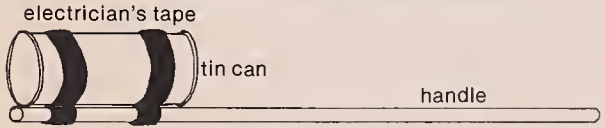
What is the coldest reading; the warmest reading?
How much does the temperature vary between the highest and lowest readings?
At what level is the temperature most consistent?
What do the snow crystals look like at each layer?
What is the relationship between temperature and snow crystal type?
Construct a graph to display your findings.

Measuring Snow Density

When predicting the amount of run-off from any given snow cover, snow surveyors must find out more than just the depth of the snow. In order to get an accurate picture of how much water will be produced when the cover melts, they must take into account the density of the snow they have sampled. This density refers to the amount of water contained in any sample when it is melted. Accordingly, the amount of water in any two samples is directly related to the age and type of snow crystals that make up each sample. Following is an accurate and straightforward method for finding the density of the different snow layers in a particular station.

You will need: jars with lids for each group
graduated cylinders
a metal spatula for each group
a core sampler for each group

The core sampler is nothing more than a tin can open at both ends. Find the volume of this can by opening one end, filling it with water and then pouring the water into a graduated cylinder. Mark this volume on the side of the can. It is preferable to use a can which contains an even number of cubic centimetres (100 cm^3, 150 cm^3, 200 cm^3, etc.). All cans used should be the same size. After removing the other end of the can, you may wish to add a handle by attaching a piece of wood as shown, however this is optional.



At your snow station, press the core sampler horizontally into the lowest layer of the snowbank. Remove the can from the bank and being careful not to compress the snow, slice off protruding snow evenly with a metal spatula. Shake this sample into a jar and seal the lid. Mark the snow level from which this sample was taken, on the jar. Repeat this procedure for all the major layers of the snowbank and label each sample accordingly. Take all the samples you have collected back to the classroom and allow them to melt.

You can now find the volume of the samples by pouring the water from each into graduated cylinders. Record their volumes in millitres for future comparison.

It is easy to find the density of the snow in g/cm^3 because 1 mL of water weighs 1 g. Thus, to find the density of the snow in the cover use this formula:

$$\text{snow density} = \frac{\text{weight of melted snow (g)}}{\text{volume of core sample } (cm^3)}$$

Therefore if the weight of the snow in a 200 cm^3 sample is 27 g

$$\text{the density} = \frac{27}{200} = .135\ g/cm^3$$

Snow surveyors determine the density and water equivalent* of the snowpack by taking single vertical cores similar to that described above. Instead of allowing the snow to melt and measuring its volume, snow surveyors weigh the core to determine its water equivalent. By this method density is found by the formula:

$$\text{snow density} = \frac{\text{water equivalent (mm)}}{\text{snow depth (mm)}}\ g/cm^3$$

The diameter of the core sample and the calibration of the weighing scales is such that the water equivalent is observed directly.

The density of snow varies from about 0.10 g/cm^3 for freshly fallen "powder" snow to about 0.60 g/cm^3 for late-season wet snow as found on the coastal mountains in late May and June.

In predicting the amount of runoff from the snowpack, snow surveyors use the water equivalent as measured at a number of different locations in the mountains.

How hard is snow?

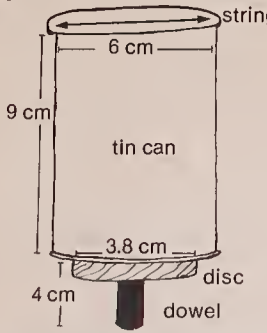
The survival of small animals under the snow depends on the strength of the cover above them. If the snow is not hard enough, it is easily damaged by the passage of large animals, skiers, snowshoers and particularly snowmobiles. One way to test snow hardness is to use a "snow penetrator."

You will need — a tin can with a volume of about 250 cm^3 with one end removed

* water equivalent is the resulting depth of water if the full snow depth were melted in place.

— a plywood disc, 1 cm thick by 3.8 cm in diameter with a 1.3 cm hole drilled in the center.
— a piece of dowel 1.3 × 4 cm
— a spatula or flat trowel
— a supply of lead pellets or rocks

Fasten the plywood disc to the intact end of the tin can. Fit the 1 cm dowel into the hole of the plywood disc. Finally, attach 10 cm of string or wire to the open end of the can to serve as a handle.



Since this experiment may destroy the profile of the snow station, it should be performed in a temporary snow station.

With the 1.3 cm dowel inserted in the bottom of the penetrator, gently place the apparatus on the intact snow layer. If the dowel penetrates the snow immediately, remove it so that the mass is distributed over the plywood disc. Add lead pellets or rocks to the tin can until the disc penetrates the snow. Penetration is accomplished when the disc just breaks the snow layer. Weigh the apparatus (including pellets or rocks) and record the mass and type of penetrator used, (either the 1.3 cm dowel or the 3.8 cm plywood disc).

You can calculate the hardness of each layer by using the following formula:

$$\text{hardness} = \frac{\text{mass of apparatus (g)}}{\text{surface area of disc used (cm}^2\text{)}}$$

$$= \frac{\text{mass (g)}}{10\ \text{cm}^2} \text{ for the 3.8 cm disc}$$

$$= \frac{\text{mass (g)}}{1\ \text{cm}^2} \text{ for the 1.3 cm dowel}$$

Looking at a Fresh Snowfall

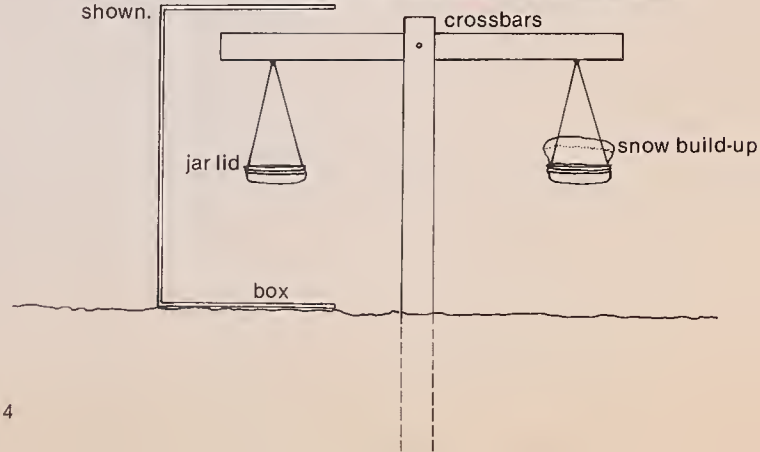
The following activities are specifically intended for use at the time of a new snowfall.

How much does a snowfall weigh?

This activity describes the construction and use of a simple balance. It is not necessary to follow this design, however, since the children can benefit from inventing and constructing their own balances.

You will need:
two pieces of wood (1 × 3 × 25 cm), nails and a drill with a small bit
two jar lids (identical)
string
a large cardboard box
weights of 1 g each

Drive a 4 cm finishing nail near the top of one of the two wood pieces. Drill a small hole in the exact centre of the other. Connect them by pushing the nail head into the hole. These pieces should move easily since they are to be used as a balance. Attach the jar lids to each end of the crossbar so that they balance, and stick this apparatus into the snow. Cover one side of the balance with the cardboard box to prevent snow from building up on one side of the balance as shown.



After a given interval, snow will build up on the uncovered side. In order to determine the mass of this build-up, carefully place the 1 g counter-weights into the covered jar lid until the apparatus balances, i.e. 4 counterweights = 4 g of snow.

You may wish to construct a chart that compares the snowfall masses after different intervals of time. You may try this during several snowfalls to compare the intensities of the storms.

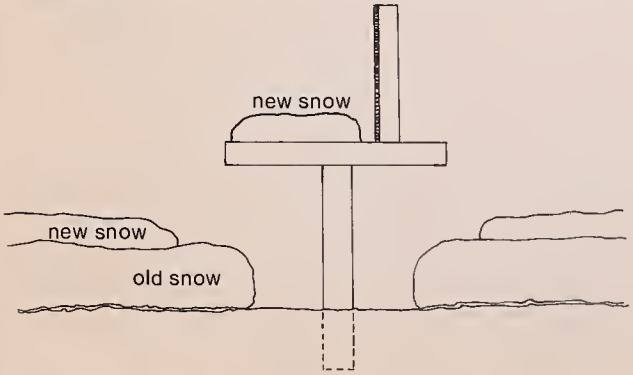
Measuring the depth of a snowfall

Following are two suggestions for building apparatus which may be used in measuring an overnight snowfall.

Building a snow table

You will need: a 30 × 30 × 1 cm piece of plywood
a 3 × 3 × 100 cm upright

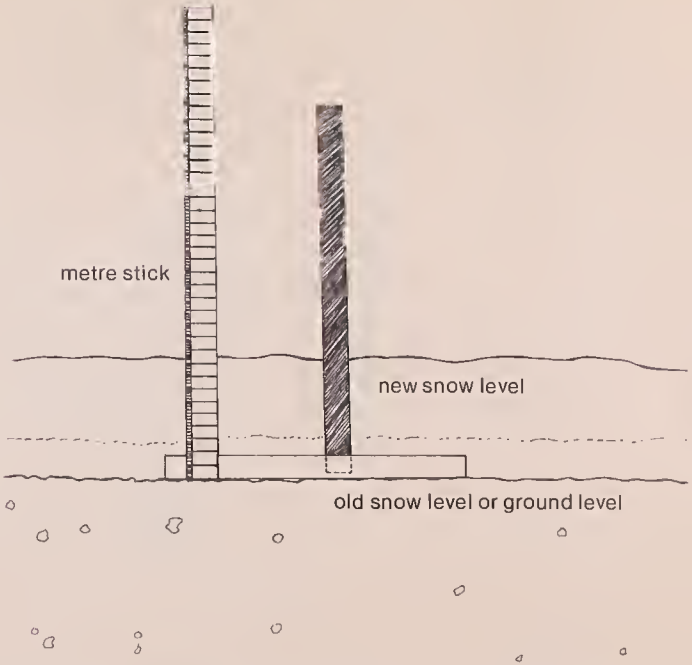
Attach the upright to the center of the piece of plywood with a screw or a nail. Push the upright into the snow, so that the surface of the snow table is well above the current snow level. After the next snowfall, you will be able to measure the amount that fell by cutting into the snow on the table and holding a metre stick against the cross section as shown.



More than one table may be used to enable taking measurements in different environments such as an open area, a sheltered area and so on. These measurements will not be accurate during a gusty wind.

Building a snow depth indicator

You will need: 60 × 60 × 1 cm plywood board painted white
a 3 × 3 × 120 cm upright pole painted any bright colour



Attach the upright to the centre of the board with a nail or screw. Place the board on the ground or snow surface. After the next snowfall you should have no trouble locating the upright pole.

Push a metre stick into the snow beside the upright, until it hits the plywood board. This will give you a fairly accurate measurement of the last snowfall. An alternative method is to attach a metre stick to the upright. The depth measurement can now be read directly from the instrument.

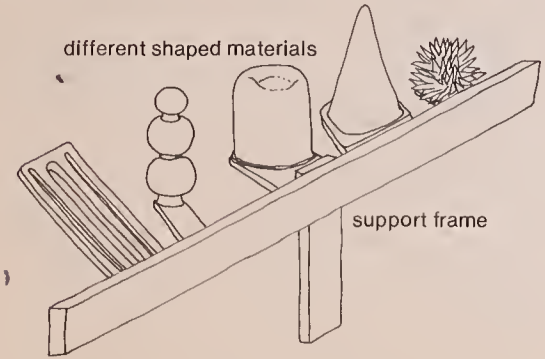
Drifting Around

During the course of their experimentation, the children may notice that the snow cover is seldom uniform in depth. Interesting shapes and drifts are formed by the action of the wind while the snow is falling. Gusts will also pick up loose surface snow and pile it on and around any objects which stand in its path. This can often be a problem when snowdrifts build up on public thoroughfares. This situation can be alleviated, however, by the proper placement of temporary snow fences. The following exercises are designed to acquaint the children with snowdrifts and to help them learn how to control drift formation, thus gaining an understanding of how and why snow fences work.

Observing snow build-up

You will need:
- several types of boards and other materials of varying shape, size and dimension.
- two 120 cm lengths of support wood, approximately 5 × 10 cm.

Nail or screw the two pieces of support wood together to form a "T". Attach the various shapes to the crossbar of the "T" as shown.



Place this apparatus outdoors during a snowstorm and return when the snow has stopped falling.

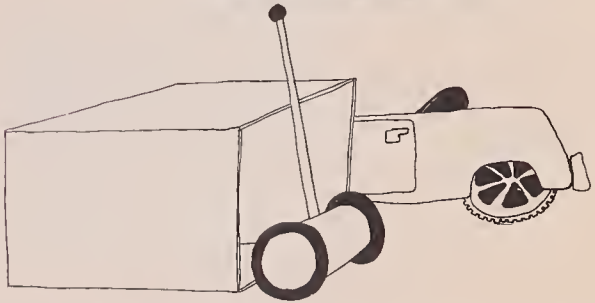
1. What kinds of shapes allow for the most snow build-up?
2. Can you predict which shapes will have more build-up on them?

Use a thermometer and wind speed indicator to answer the following.

1. What was the temperature at the time of the build-up?
2. Is there a different type of build-up when the temperature differs?
3. What was the wind speed?

Snowdrift shapes

You will need: assorted objects of the students' choice — this includes cardboard boxes, bottles, toys, etc. (almost anything will do)



Find a large, open area in which the snow depth is relatively uniform and which is not heavily trafficked. Have the students place their objects half-way into the snow in a random fashion. If the snow is fairly light and dry, drifts will form quickly. The children may now try to predict the shapes of the drifts that will be formed by the objects they have placed in the snow. This activity is especially effective on a windy day.

1. How can you make a long drift?
2. How can you make a wide drift?
3. How can you make a small drift?

You might want to make oddly shaped drifts or a snow

sculpture by allowing snow to build up against an unusually shaped object.

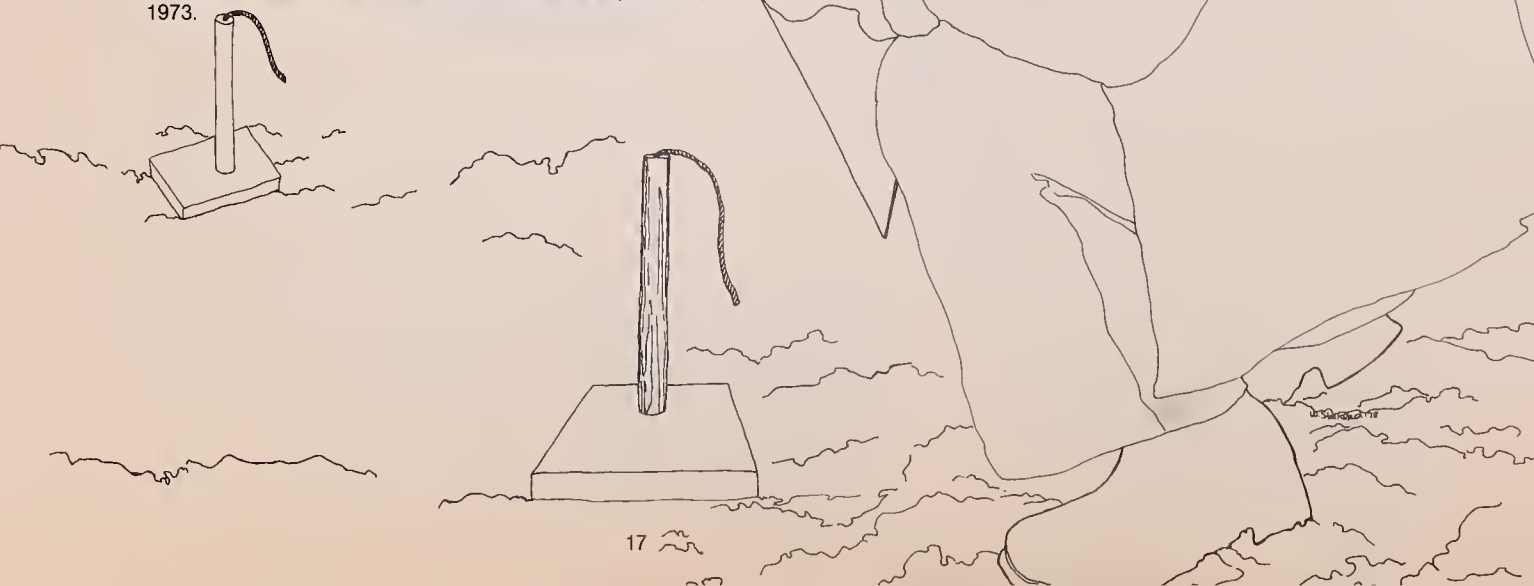
Snowdrifts and wind direction

You will need: 10 to 15 plywood boards (at least 60 × 60 cm)
wind direction indicators (tell-tails)

Select an open area, such as a playing field or meadow similar to the one used in the previous experiment. Using the wind direction indicators, find the direction of the prevailing wind. (See the WEDGE unit on wind for making and using wind indicators.*) Push the boards into the snow so they face a variety of directions. Have the children predict which boards will cause the most snow build-up. After a time the children may measure and record the depths of the drifts that have been formed against each board. They may now compile this data in the form of a map or diagram.

You might wish to have the students repeat the experiment. Rather than placing the boards randomly, however, the children could try to face them so that the largest possible drifts are formed.

* *Cast Your Class to the Wind.* WEDGE, University of B.C., 1973.



More Things to Do

1. Looking at pollution in the snow

The students may be surprised or shocked to discover that even snow is affected by pollution.

You will need: funnels
filter paper
jars
test tubes

Place the filter paper in the funnel and fill it to the top with snow. As the snow melts, the water will pass through the paper, leaving behind impurities. The paper may then be removed, dried and kept as a permanent record of the students' findings. These may be later compared to samples taken from various areas at different times of the season.

Another method of observing the impurities in a snow sample consists of putting a small amount of snow into a beaker and allowing it to melt. Then fill a test-tube with this melt and hold it in front of a powerful light (such as a slide projector) in a darkened room. This procedure may be used to project an image of the materials in suspension onto a screen for observation. It might be interesting to compare this sample to other snow melts and other water samples. These samples may be taken from streams, lakes, ponds, taps and so on.

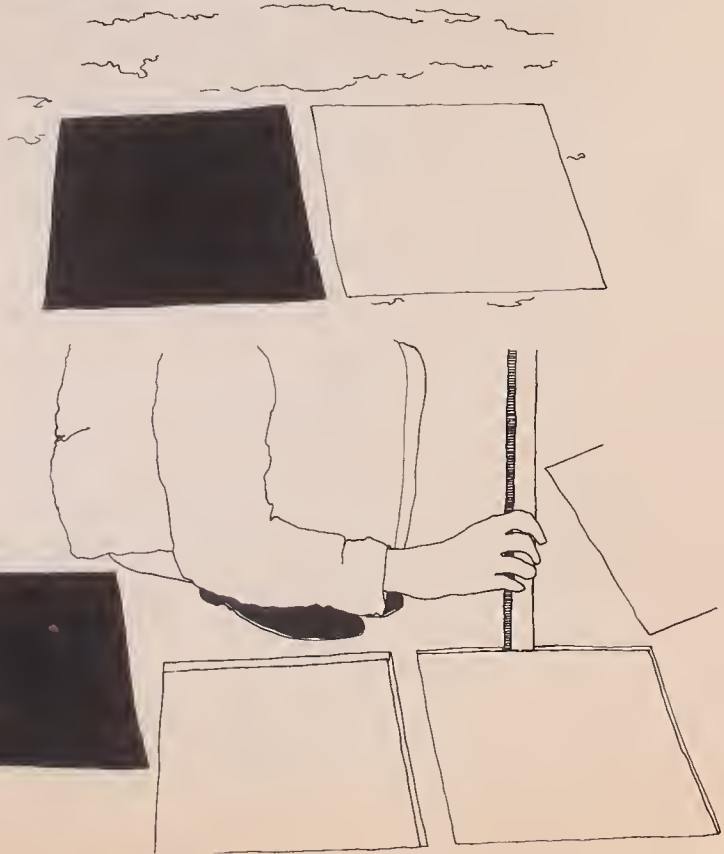
1. What did you find in your sample?
2. How do impurities get into the snow?

3. How is country snow different from city snow?
4. Why would snow containing a lot of pollution have a different melting rate than snow that contains very little pollution?

2. Testing melting rate

You will need: floor tiles of various colours, about 30 × 30 cm
metre sticks

Carefully place the various coloured tiles on the surface of the snow. Place them lightly so that they sit on the top layer of the snow without breaking the surface.



Leave them to sit in the sun a full day and return to the location in 24 h. Measure the depth that each tile has sunk down into the snow.

1. Which colour of tile has sunk the deepest?
2. Which colour of tile has sunk the least?
3. How is the colour of the tile related to the rate of melting?

This experiment can be tried in an open, sheltered or intermediate area. Best results will be attained on a bright, sunny day in an area that will not be disturbed. Tempera paints may be sprinkled in marked off squares if coloured tiles are not available. The students should try to sprinkle the same amount of powder in each plot and somewhat the same results can be expected.

3. Salt and snow

You will need: a supply of rock salt
beakers
thermometers

Sprinkle some salt on a highly trafficked area, on a medium trafficked area and on an area where there is little or no traffic. Come back in a few hours to observe and record the results.

1. In which area has the snow melted most? the least?
2. What causes the snow to melt?
3. What were the weather conditions at the time of the experiment? (Wind, temperature, etc.)
4. Does the water refreeze overnight?

In the classroom, place a sample of loose snow into a beaker and record the temperature every thirty seconds. Place an equal amount of loose snow into a second beaker and add five grams of salt. Record the temperature every thirty seconds.

1. Does the salt raise or lower the temperature of the snow?
2. Does salt speed up or slow down the melting rate of snow?
3. What was the temperature of the classroom when the experiment took place?
4. Compare your results with those of your classmates.

PART TWO

Wintertime Ecology

The ecological balance of the forest is fragile at any time of year. This fragility is increased many times over, however, in the winter season. The survival of the forest plants and animals depends on a number of key factors. The animals that do not migrate or hibernate depend on their ability to adapt physically to their winter surroundings. The trees and perrenial plants must also undergo physical changes, whether they be strikingly obvious or extremely subtle.

The winter cold is most destructive to the survival of the small forest animals right before the first snow fall. It is not until the snow forms a thick cover, that its insulating properties help it to become a warm winter blanket under which a great variety of small animals comfortably live out the cold season.

If the students have completed the activities concerned with the physical properties of snow, they should be well acquainted with its insulating value. In the event that they have not completed this section, it is highly recommended that they at least try the activity, "Taking the Snow's Temperature," before studying winter ecology.

Because it is necessary to carry out the following activities in the winter forest, you may decide to organize a series of day field trips. During their excursions, the students can be encouraged to protect the delicate environment. An easy way to invite this type of behavior is to have them stay on the trail or walk in each other's tracks. Also when collecting samples of any sort, you might encourage the children to pick their specimens from several areas rather than concentrating in any one area. In this way, they are least likely to upset the ever-delicate balance.

Plants, Trees and Flowers

In order to help identify the trees, shrubs and flowers that will be encountered in the winter forest, it is recommended that the teacher bring along a good field guide.

Identifying trees

An interesting way to start your study of winter ecology is to take the students for a walk through the forest and have them observe their surroundings. You may wish to make the

activity more specific by having the children attempt to identify the different trees they come across. The students can carefully collect needle samples from various evergreens. It is suggested they do not break off branches and that they do not take all their samples from one or two trees. Once the children have collected their samples, they can try the following:

1. Using a field guide try to identify the samples.
2. Observe the similiarities and differences in shape, colour, texture and so on.
3. Cut sections of different parts and observe their structure under a microscope.

FOR YOUR INFORMATION

The key to winter survival of trees lies in their ability to adapt. Freezing weather can cause ice crystals to form in the cells of the trees. As the liquid in these cells begins to thaw in the spring, these crystals are set in motion thus puncturing cell membranes and killing the cells. Widespread tree damage would occur each year if the trees had no means of counteracting this process.

In the case of deciduous trees, water content is lowered and their metabolism is slowed down. As winter approaches nutrients are cut off from the leaves and some leaf nutrients are re-absorbed into the rest of the tree. The leaves are then dropped off and the spots where they were attached are sealed.

Cone bearing trees, on the other hand, do not lose their needles. Instead, the water content in the needles is reduced and the oil content increases. In this way both types of trees survive the winter. The cone bearers grow little in the winter, however, and the deciduous trees, not at all.

Identifying winter buds

After a tree has lost its leaves, it protects the next year's growth by forming scaled winter buds. The scales on these buds seal the delicate baby leaves in a tough, windproof cover.

Have the children collect samples of these buds and identify them. They may also dissect the buds to find out what's inside them. A good test is to cut the buds open and taste them. None of them are poisonous and most have a high sugar content which makes them taste very sweet. They can also compare the structure of the bud scales with the young leaves within the bud.

Bark observation

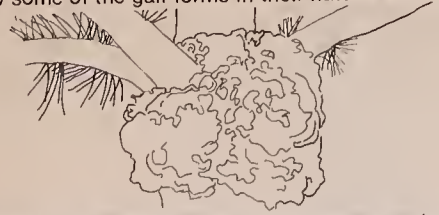
Have the students collect various bark types from the ground or from dead trees only. Observe the features that make each type of bark unique. In what ways are they similar or different? How does the bark of a tree help it survive the winter?

Lenticels are made up of loosely packed cells which look like scars that have been spread over the bark's surface. It is through these lenticels, that the tree exchanges gases or breathes, in the growing season. The lenticels of every species of tree or shrub are unique and can thus be used to identify the trees, even when the leaves are not present.

Observation and identification of galls

Galls occur in all parts of trees and shrubs and are identified as lumps or swollen globes on branches. Most are caused by the injection of an insect egg into the bark. This causes an irritation which in turn causes an overabundant cell growth. In most cases, the insect lives on the plant matter inside the gall and eventually eat its way out. In the winter time, galls on the stems or thin branches of trees are most visible. These galls are unique and an expert can use them to identify both the species of insect and the species of tree or shrub.

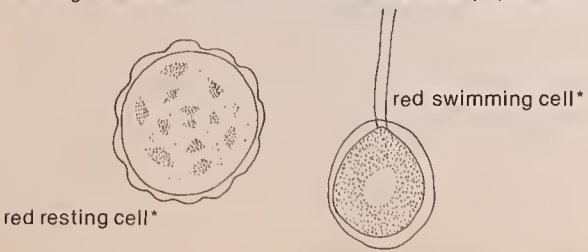
Have the children conduct a survey of insect gall populations in a specified area. They can then map this area and record the incidence of types found. The children may wish to draw some of the gall forms in their natural environment.



A collection of various galls can be taken back to the classroom and dissected. The children may even locate the egg or insect inside. By observing the amount of plant matter that has been eaten, they can guess at the approximate age of the gall. If the insect is no longer inside, the student should be able to find its escape hole.

Red Snow

Snow patches lasting through late spring and into the summer rarely remain white. In fact, they often are pink to red or orange in colour. Sometimes these so-called "red snows" are so brightly coloured they are visible for a mile or more. The colour results from the presence of millions of microscopic plants belonging to the algae. Their tiny cells are spherical or elongate and are often ornamented. They contain colored materials within their cells which probably serve to protect against the intense radiation of ultra-violet light present at high altitudes. When the snow has the bright red (or orange) colour, the algae are usually in a resting stage that can be easily windborne or can settle on the soil surface after snow melts. The bright red appears when masses of the cells accummulate as the snow disappears. The algae serve as food for the small animal populations (some of which are also microscopic) that live in the snow habitat.



*As seen under a microscope

Red snow has often been recommended as a food source in survival guides. However, it is a poor source of protein and may, if eaten in large amounts, make you mildly ill. Inspite of the above, it does taste a bit like watermelon! Try a bit.

More Things to Do

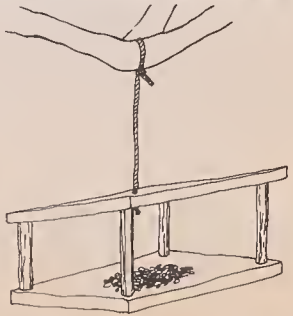
— Try to find a flower in the snow. Do NOT pick it. Leave it for someone else to enjoy. Draw its picture or photograph it for identification purposes.
— Find out which flowers survive the winter. Write a report on your findings and illustrate it with colour photographs or drawings.
— Make a survey of tree damage as winter progresses. This could include damage both by climate and animals. Students may wish to take a series of photographs for display.
— Make a survey of the types of foods that are available for herbivorous animals in the winter. (seeds, bark, berries, nuts, etc.)
— Dig down to the ground and observe the vegetation underneath the snow cover. What types of vegetation are there? Are any types still growing?

Winter Birds

Many species of birds are abundant and easy to observe in winter. This makes bird observation a good place to start when observing animal behavior.

Building a bird feeder

The construction of a bird feeder may be left up to the imaginations of the students. They may make it as simple or as elaborate as they wish. All that is really needed is a platform that is covered to protect the food from the snow. An excellent reference for bird feeder designs is Shutz's book



*How to Attract, House and Feed Birds**. Once the feeder is in operation, you may wish to have the students answer some of the following questions:

1. What are the birds' favourite foods? Do some species prefer specific foods?
2. What kinds of birds remain during the winter?
3. Observe their feeding habits and behaviour. Is there a bully? What is the pecking order?
4. Observe the tracks left by the birds. What do they tell you about what went on?
5. Do the same birds come back every day?
6. How do the birds find the feeder?

Observing birds in the wild

After having observed birds around their feeders, the children may want to see them in their natural environment. All they will need is a good field guide** and perhaps a pair of binoculars.

Here are some guidelines for observation:

1. Find out how birds get their food in the wild when it snows. What do they eat?
2. How do they keep warm?
3. Have you seen them ruffle their feathers? Find out why they do this.
4. Can you identify the birds that you see?
5. Where do they live?
6. Find out what has happened to the birds that leave the forest before winter comes.

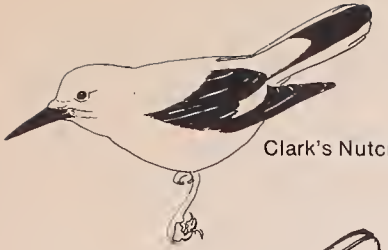
Since deciduous trees lose their leaves in winter, bird nests are easily found and observed. DO NOT REMOVE THE NESTS, as they are often re-used.

1. Discuss the placement and function of the nest.
2. What is the nest made from?
3. What does the nest look like? How big is it? What shape is it? Draw a picture or take a photograph of a nest.
4. Take a census of the bird population in your neighbourhood by counting and recording the number of nests in each block. Draw a map to illustrate your findings.

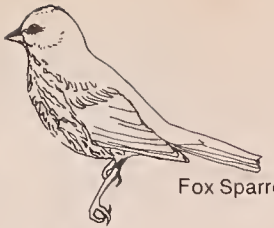
* Schutz, W.E. *How To Attract, House and Feed Birds,* The Bruce Publishing Company, New York 1970.

** See Petersen's Guides in the bibliography.

Winter Birds



Clark's Nutcracker

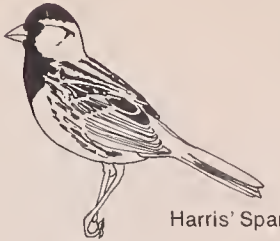


Fox Sparrow

House Sparrow

Black-capped Chickadee

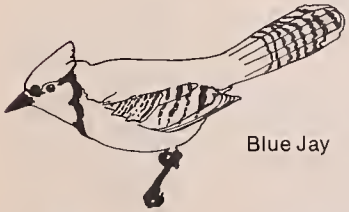
Canada Jay



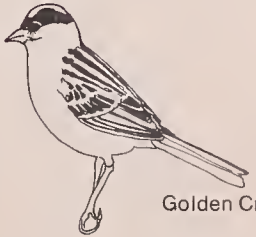
Harris' Sparrow

Winter Wren

Brown Creeper



Blue Jay



Golden Crowned Sparrow

Common Flicker

Common Crow

Hairy Woodpecker

Steller's Jay

White-Crowned Sparrow

Bohemian Waxwing

Evening Grosbeak

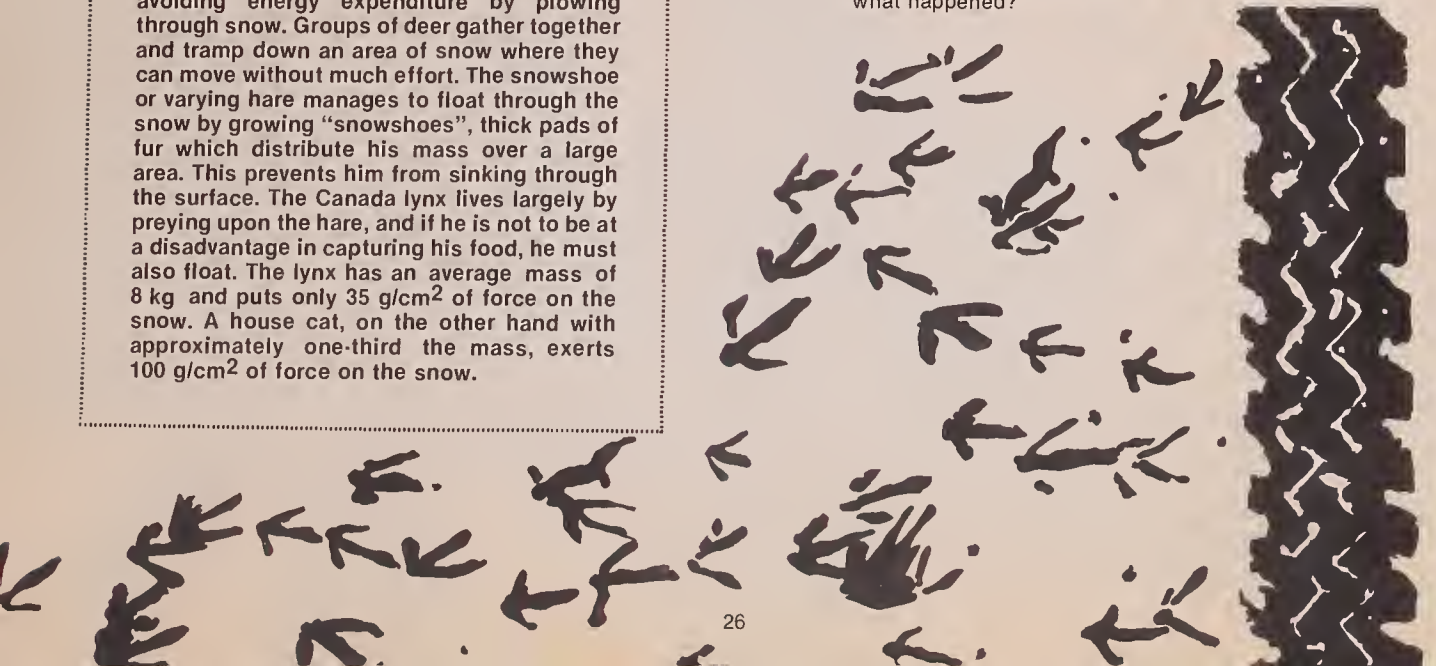
Pileated Woodpecker

Animals that Live in the Snow

The winter environment provides an excellent opportunity to observe the behavior of many forest animals. Even if the animals themselves are not observed, their tracks in the snow provide an interesting source of information.

FOR YOUR INFORMATION

Plowing through snow is difficult work as anyone knows who has attempted to travel through deep unbroken drifts. Moose solve this problem by their method of walking. As they walk, their legs move up and down like pistons, and so avoid dragging through the snow and wasting energy. Deer, on the other hand, play "'follow the leader", so that those in the rear have the trail broken for them by those in front. "Yarding" is another method of avoiding energy expenditure by plowing through snow. Groups of deer gather together and tramp down an area of snow where they can move without much effort. The snowshoe or varying hare manages to float through the snow by growing "snowshoes", thick pads of fur which distribute his mass over a large area. This prevents him from sinking through the surface. The Canada lynx lives largely by preying upon the hare, and if he is not to be at a disadvantage in capturing his food, he must also float. The lynx has an average mass of 8 kg and puts only 35 g/cm^2 of force on the snow. A house cat, on the other hand with approximately one-third the mass, exerts 100 g/cm^2 of force on the snow.



Finding and observing tracks

Go outside and find as many types of tracks as you can. These may be human tracks, tire tracks, animal tracks, sled tracks and so on. Compile a list of your findings. See if you can find a really unique type of track. Are there any tracks that are difficult to explain?

Select the most interesting of your tracks and either photograph or draw it to take back to the classroom.

Share the different track selections with the class.

1. In which direction were they going?
2. Can you tell if they are animal or machine made?
3. Do they tell you something about the mass of whatever made them?
4. Are the tracks made by rolling, jumping, walking, hopping, running, sliding, etc?
5. In what areas do you find the tracks occurring most frequently?
6. By following animal tracks, can you relate a story as to what happened?

Making permanent casts of tracks

Upon finding a set of undamaged, interesting tracks, the students may wish to make their discovery permanent by making a plaster cast.

You will need:
- plaster of Paris
- water spray bottles
- cardboard strips (approx. 8 × 20 cm)
- paper clips
- Borax (optional)
- toothbrush or small, stiff brush
- paper cups
- salt

1. Choose the clearest track and spray it with a light mist of water. This will harden your track with a thin coating of ice.
2. Once the track has been strengthened with ice, fit the cardboard strip around its perimeter to form a collar. Push the collar about 2 cm down into the snow and fasten it together with a paper clip.
3. Make a mixture of plaster of paris and water in a paper cup. Stir out all the lumps until this mixture resembles whipped cream. Adding a pinch of salt will speed up the hardening process.
4. Pour the plaster of paris mixture slowly and carefully into the collar until it is about 2 cm deep. With a pencil or twig, tap the collar lightly as you pour. This will cause the plaster to work itself into any small crevices. You might wish to push a paper clip half-way into the wet plaster so that the track may be easily hung for display.
5. The casts should be left to harden for about 1 h. At this point, they may be removed from the snow and the cardboard collars taken off.
6. After making sure that the face of the track is completely hardened, clean and smooth it by rubbing lightly with a small brush.
7. If you wish to harden your cast further, you can boil it in a solution of Borax. Add approximately 5 mL of Borax to 1 L of water and boil.
8. Try painting and varnishing your cast. Make a class display of your masterpieces.

The above process produces a negative cast of the track. For purposes of accuracy, you may wish to repeat this process using your cast, and a positive imprint will result.

To prevent the two casts from sticking together, coat the first with a thin coat of petroleum jelly.

Taking a wildlife census

After having made a study of animal tracks, the students may wish to find out just how many animals live in a particular area. This may be tackled in any way the teacher wishes. The following is a simple method of getting a fairly accurate count.

Have the students pace out an appropriate area. Pacing will produce a trail in the snow which will mark the boundaries of the census area. If you plan to return to observe the same area, it is suggested that you establish the boundaries of your census area by tying surveyor's tape to appropriate trees.

If you wish the students to work in small groups, you can have them divide the main census area into smaller parts. Care should be taken to walk only on the boundaries of these small sections, so that little of the area will be disturbed.

The groups should keep a record of their findings and observations.

- The students may notice that there are two general types of tracks. Find out which are made by large non-migrating mammals and which are made by small mammals who live under the snow.
- Can you identify any of the tracks?
- How many different types of tracks can you find in the census area?
- Is there evidence of one animal chasing another? Can you find a "kill site"?
- Can you find any animal homes in the snow?
- Make a chart or graph to display your findings.

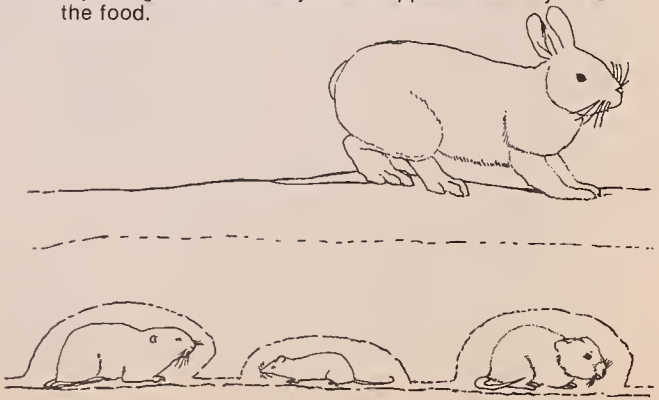
Animal homes in the snow

You will need:
- various types of food, such as - fruit, vegetables, seeds, nuts, bread, meats and so on
- binoculars

Observant students will eventually notice small sets of animal tracks which lead to holes in the snow. These are ventilation holes which allow small mammals to spend most of the winter season safe and warm beneath the snow cover. They may be identified by the presence of large compound ice crystals on the outside of the openings. These crystals are produced by water from respiration which condenses upon reaching the cold air at the end of the ventilation shaft.

Once the homes have been found and identified, the students may spread small amounts of food nearby and retreat to observe the results. Here are some interesting things to do and discuss:

1. What food types are preferred?
2. How much of each is eaten?
3. Why do you think certain foods are preferred? Do you think it is because of their taste or because they are close to the hole? Try moving the preferred food farther away. What happens? If nothing happens, try returning to the site at a later time. You will probably see some sort of evidence of the animal that lives under the snow.
4. Can you follow the animal's route as he was looking for food?
5. Try to figure out exactly what happened since you left the food.



The students may wish to leave live traps close to the animal homes that they have been observing. These may be baited with preferred foods in order to observe the animals they have been tracking.

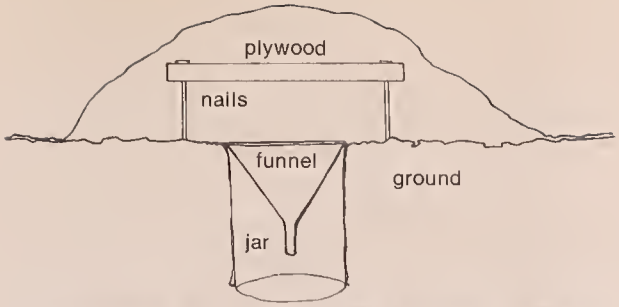
When baiting a live trap, it is EXTREMELY important to include an abundance of insulation material. This will prevent the animals from freezing over night. The animals should not be kept for too long and let loose near the spot where they were trapped.

Tiny Creatures that Live in the Snow

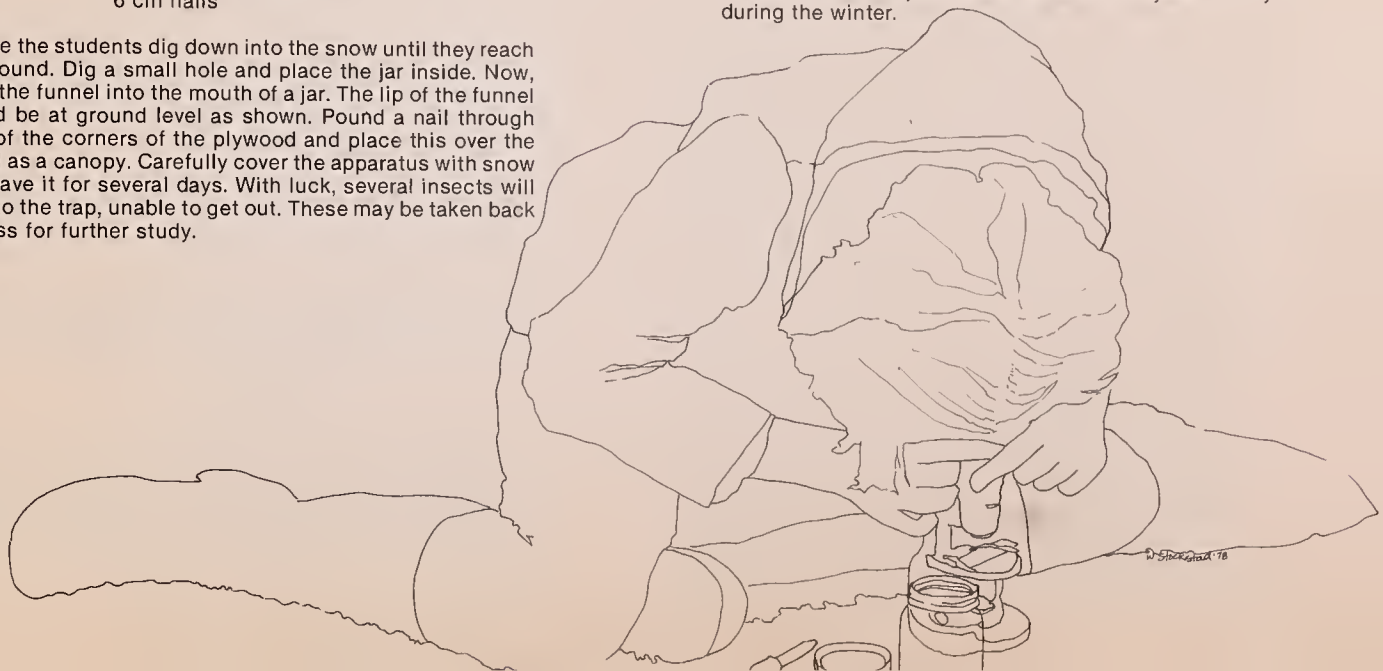
The children may be surprised to find that many species of insects live in and under the snow cover. They may be easily trapped in the following method:

You will need:
- a glass jar
- a funnel that just fits the mouth of a jar
- several types of food that will be used to attract the insects
- 5 × 5 cm × 6mm plywood
- 6 cm nails

Have the students dig down into the snow until they reach the ground. Dig a small hole and place the jar inside. Now, place the funnel into the mouth of a jar. The lip of the funnel should be at ground level as shown. Pound a nail through each of the corners of the plywood and place this over the funnel as a canopy. Carefully cover the apparatus with snow and leave it for several days. With luck, several insects will fall into the trap, unable to get out. These may be taken back to class for further study.



The students can work with the specimens in several ways:
1. Identify your insect.
2. Draw its picture.
3. Study it under a microscope or hand lens and draw close-ups of its parts.
4. Find out whether your insect is active all year or only during the winter.



PART THREE

Safety and Survival

This section is not meant to be a camping guide in itself. It should be used as a reference to activities and helpful hints for an experienced snow camper. Reference to good snow camping guides will be made in the bibliography.

All of the activities are designed to serve a dual purpose. They can be carried out on the school grounds as well as in a camping situation. The students should have some practice to become relatively proficient in the construction of shelters before camping is attempted.

These survival activities are designed to develop an attitude of safety-mindedness in the students, which may provide a better chance of survival if an emergency should occur. Students who are safety-minded will also be more comfortable and at home in the winter environment, while retaining a healthy respect for its potential danger.

Keeping warm

One of the most important aids to winter survival is the ability to keep warm. The students should try some of the following activities so that they will be given an opportunity to use their own common sense and logic in figuring out how to keep warm in the snow.

1. Try running around in the snow for a few minutes and then suddenly stopping. What happens when you build up a sweat and then stop running?
2. Lie down on top of the snow either curled up or spread out. Now try digging under the snow cover and lying down.
3. Stand out in the open. Does the sun warm you or does the wind make you cold?
4. Stand in a sheltered area. Does the shelter from the wind warm you or does the lack of sun cool you down?
5. Use a thermometer to measure the temperature of your skin. Measure your skin temperature where it is exposed to the air, covered or where it is damp, etc.
6. Record and discuss the results to find which areas were warmest. Compile a chart or graph which illustrates the most efficient way of keeping warm.

The students should discover that the hardest body parts to keep warm are the head, feet and hands. It is often a problem for children to acquire adequate footwear because their feet are growing. This makes the purchase of expensive boots seem unreasonable. The importance of good waterproof footwear cannot be over-emphasized, however, since experience has shown that the single greatest problem in snow camping is coldness due to wet feet.

Accordingly, the only way to survive the winter environment is to stay warm and the only way to stay warm is to stay dry!

How cool are your nerves?

The students may be interested to find out where their temperature nerves are located and how these nerves effect the body's reaction to temperature change.

You will need: thermometers
nails
a pail of warm water

Place a few of the nails in the warm water. Put the rest of the nails into the snow, so that they get cold.

Choose a partner and blindfold him. Have him hold out his hand palm down and touch either a warm or cold nail to the back of his hand. Have him tell you which are warm or which are cold nails. Repeat this several times. Change blindfolds and try the process again.

What have you found out about the nerves in the back of your hand? Make a tracing of your hand and map out the places that register hot or cold.

— Are there more hot or cold spots?
— Are the temperature spots distributed evenly?
— Which temperature spots were most sensitive?
— Compare your map with other students maps. How do they differ? How are they similar?

Lighting a fire

An interesting activity for the students is to light a fire in the snow. If the children have never lit a fire under normal circumstances, they may find this extremely difficult. Therefore, you may want to bring along some solid barbeque starter.

The best place to collect firewood is from the lower dead

branches of trees. This wood is most likely to be dry and will not harm the tree when removed.

Make a platform of firewood or branches and build your fire on top of this platform. You can keep warmest by building a snow wall around the fire reducing the wind. The circumference of this wall should be large enough so that all of your group is able to sit inside. Be careful not to build your fire under an overhang of snow, such as on the side of a cliff or tree branch. If you do, prepare to get wet or have your fire put out!

If the fire is built in deep snow, the students will be fascinated to see how it gradually sinks deeper and deeper over a period of hours. Some fires have been known to sink straight down 2 or 3 m and still keep burning!

Getting around in the snow

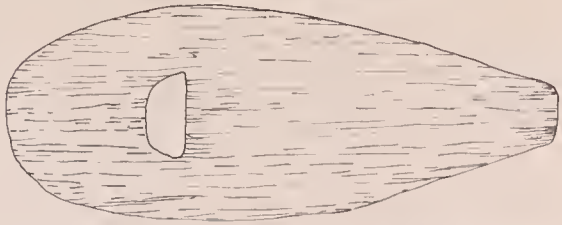
To round out a study on winter survival, it is suggested that the teachers introduce their students to the various methods of moving about in the snow. Students can be encouraged to walk in deep snow without the use of snowshoes, thus motivating them to design their own methods of getting around in the snow.

In the classroom, students can design and construct their snowshoes with the intention of using them in the field. At this point, it should be noted that students should not attempt long hikes in deep snow before thoroughly testing their snowshoes for durability.

When attempting any hike, students should bring all materials necessary for snowshoe repair.

Following are some general suggestions for building 3 types of snowshoes.

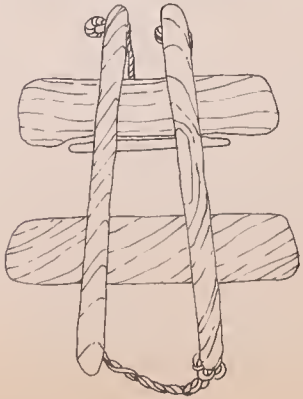
1. Plywood or plank snowshoes

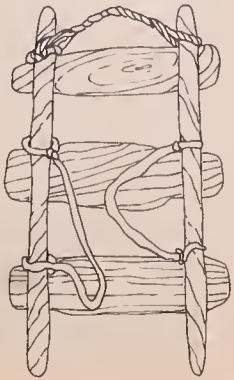


The wooden snowshoe is cut from a single piece of wood with holes cut for the toe and for attaching straps.

2. Ladder snowshoes

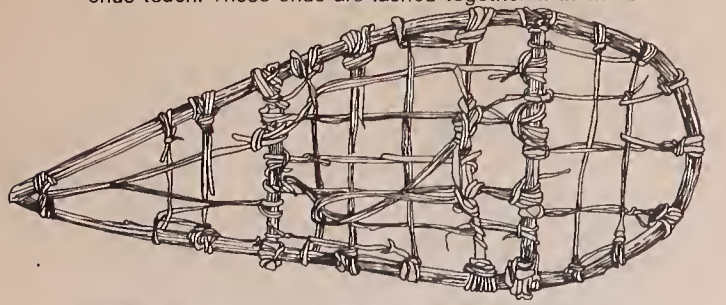
The ladder snowshoe consists of 2 struts and 2 or 3 crossbars which are screwed to struts with brass (or non-rusting) screws. Thongs are attached in the appropriate places to secure the foot.





3. Alder snowshoes

These snowshoes are designed for temporary use and can be constructed in the wild. They are made by cutting thin alder branches at least 1 m long and bending them until the ends touch. These ends are lashed together with twine or

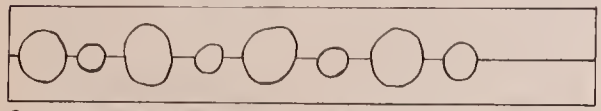


leather thonging. Two or three crossbars of alder may be lashed to this frame for support. A network of thonging or twine is then added to strengthen the snowshoes.

Building Shelters

The following are suggestions for building several types of snow shelters. These have varying degrees of difficulty and are designed to be used in different winter conditions. Shelters such as the quin-zhee or igloo should only be attempted when alternate shelters are available, as they tend to take a long time to construct.

You will need: shovels
scoops
spatulas and other digging materials
plastic tarps or sheeting
"snow knives"*

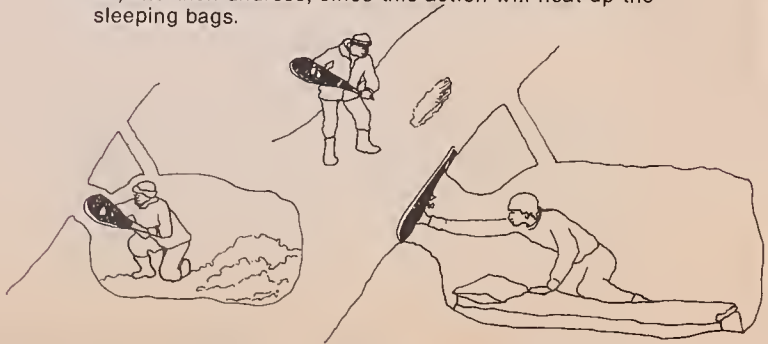


Cut the board in half and 2 snow knives will be formed.

*Snow knives can be made by cutting a 10 X 60 cm piece of 6 mm plywood and drilling alternating 1 and 2 cm holes down the centre of the board. See diagram.

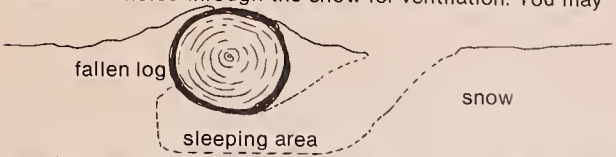
The bank or drift type shelter

1. This type of shelter can be made only where the snow is fairly deep. Find a snow bank where the depth of snow reaches at least 3 m. Such a bank could be found at the edge of a stream, side of a lake or small hill.
2. The first person starts digging into the bank with a shovel for about 1 m, and then starts to hollow out a space big enough for two.
3. At this point the second person enters and starts hollowing out the bank until there is enough room for three. This process is continued until all the students are inside digging out the bank. An ideal size will hold 5 to 6 students.
4. When the main area is hollowed out, the roof should be at least 30 cm thick. There should be an area for cooking with a ventilation hole with a diameter of at least 20 cm directly above.
5. Beds should be carved out of the snow walls at least 60 cm above floor level. Plastic should be laid down for flooring and may be used on the beds to prevent moisture from getting in the sleeping bags.
6. Candles may be used for light, and even give off a little heat. Do not use propane or kerosene lamps, or large open fires as they use too much oxygen.
7. Build a door out of snow to keep the wind out of your shelter. If the door fits tightly, a lower ventilation shaft should be dug out. Make sure that your ventilation shafts are at an angle so they do not fill up with snow overnight.
8. Make sure boots are kept inside or they will freeze overnight.
9. The children should sleep in their long underwear, **not** their clothes. The clothes should be stored in the sleeping bag overnight to keep them warm and dry. The students should get into their sleeping bags fully clothed, and then undress, since this action will heat up the sleeping bags.



The fallen log shelter

This is a good shelter for emergency situations and is best for 1 or 2 people. Find a fallen log which is well-covered in snow, dig underneath and clear out a sleeping area. Poke one or two holes through the snow for ventilation. You may



need to pack this shelter to make it windproof, but this makes a quick and easy shelter with a minimal amount of work. You may use your pack or snowshoes for a door.

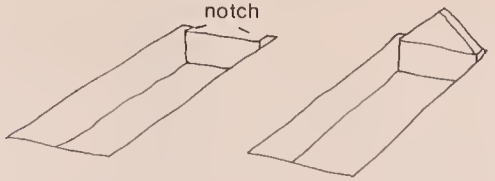
The wooden frame shelter

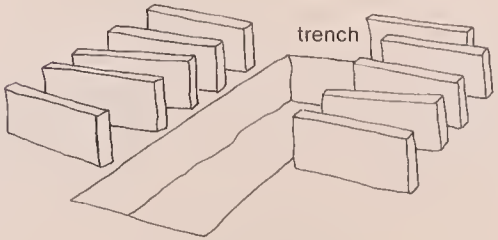
This is another emergency type shelter. Using several wooden poles or branches, build a lean-to or tee-pee frame.

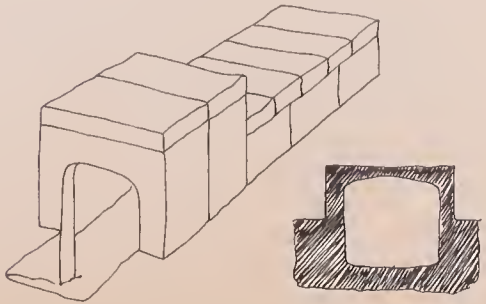
Cover this frame with a tarp or sheet of plastic. Then, cover the entire shelter with snow for insulation. Remember to provide ventilation holes.

The trench shelter

This is an easily built one-man shelter. Using your own knife, cut blocks out of snow to form a trench about 1 m deep × 1 m wide X 3 m long. Place a number of tree boughs or branches over the trench. Insulate your trench by piling the bricks you have cut over the boughs.

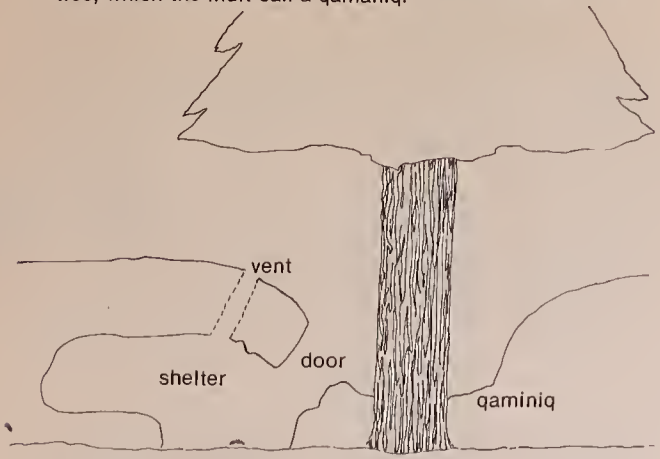






The qaminiq shelter

As the snow falls in the forest, much of it is caught in the trees before it reaches the ground. This causes a bowl shaped depression in the snow cover around the base of the tree, which the inuit call a qamaniq.

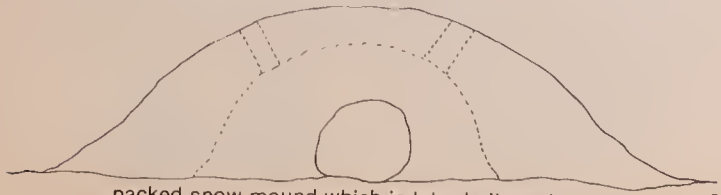


After finding a suitable tree, dig outward from the base into the snow cover. This shelter can be made much the same way as the bank-type shelter. Care must be taken not to walk on the roof. To safeguard against this, you may wish to mark the area around the roof with surveyor's tape.

The quin-zhee shelter

This shelter is good for areas where the snow packs easily and where snow banks or snowdrifts are not available.

The quin-zhee is a semi-permanent shelter and is easy to build, even if the snow cover is not deep.



packed snow mound which is later hollowed out

In an open area, form a large mound of snow. Let this mound sit for a few hours so the snow will settle. When the snow seems well-packed, cut a door and hollow out the inside. Poke out your ventilation holes and build a raised sleeping platform.

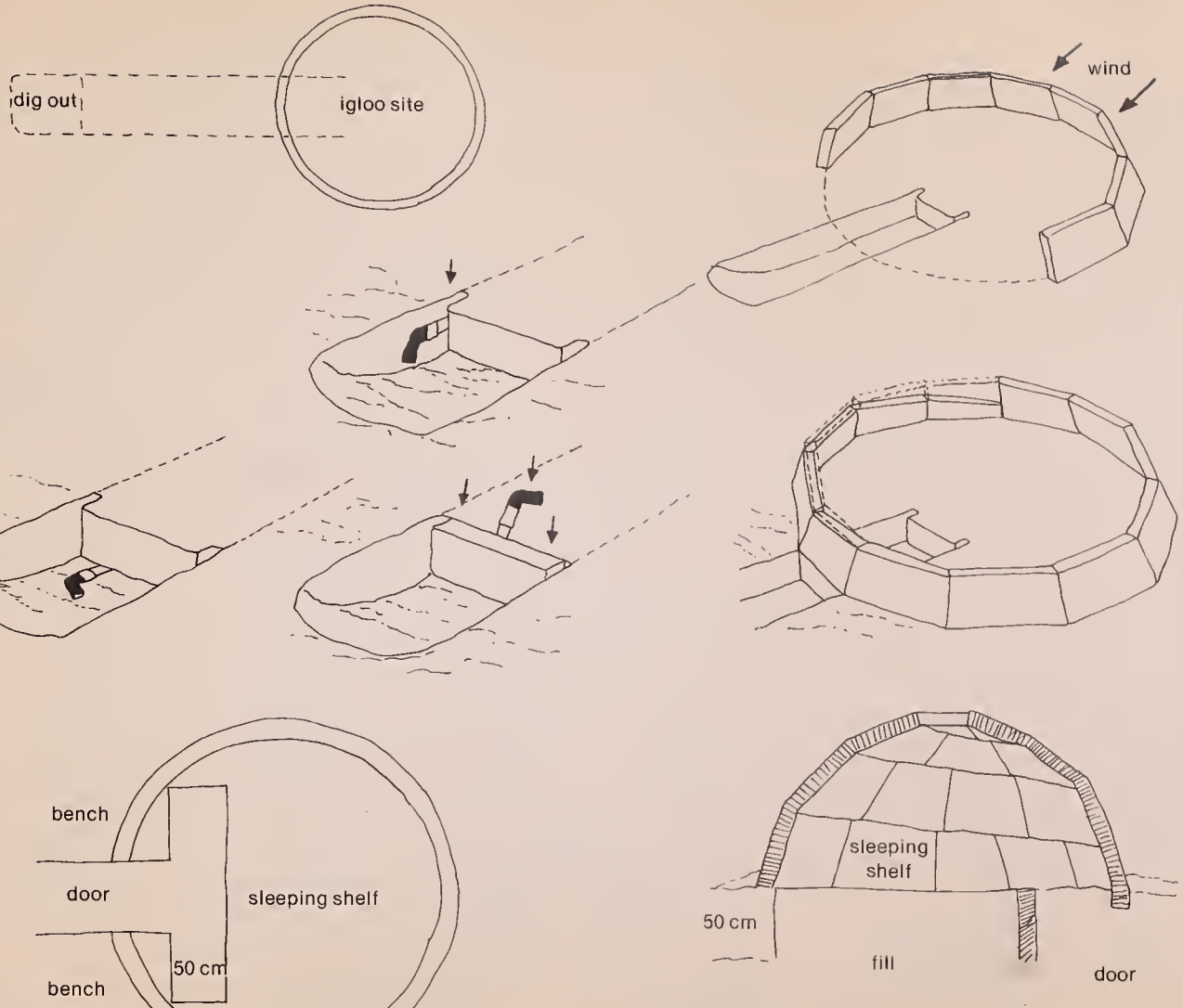
The igloo

This type of shelter is appropriate only when the snow is ideal for cutting blocks. If the surface snow is too light, good cutting snow can sometimes be found by removing the top layer and using the snow underneath.

1. Begin by marking out a circle approximately 3 m in diameter. Start with blocks taken from inside this circle in order to lower the floor.
2. The blocks should be about 75 × 45 × 15 cm. They should be cut on the the sides so that the inside of the igloo will be smooth. This prevents excess dripping inside the igloo. Each block should be bevelled on the top and the bottom so that the wall will tilt inwards. They should also be bevelled on the ends so that each block is kept from falling by the preceding block.
3. When the first row of blocks is complete, all cracks and joints should be filled with loose snow to increase structural stability. This packing should continue as construction proceeds.
4. When the first row is complete, the last 3 blocks placed should be cut diagonally to form a ramp. The first row of the next blocks will be placed next to this ramp, and the following rows are continued in an upward spiral.
5. When the dome is complete, care should be taken to smooth the inside as much as possible to prevent dripping. Also, an air vent about 20 cm in diameter should be cut near the top of the dome.
6. The entrance hole should be cut underneath the wall and should be protected by a small archway of blocks. If possible, this doorway should face 90° to the prevailing wind. This will cause a slight suction and serve to help ventilate the igloo. Ventilation should be increased if cooking is done inside.

NOTE

When using any shelter ALWAYS KEEP YOUR SNOW SHOVEL INSIDE, in case of overnight drifting or collapse.


dig out
igloo site
wind
bench
door
sleeping shelf
50 cm
bench
sleeping
shelf
50 cm
fill
door

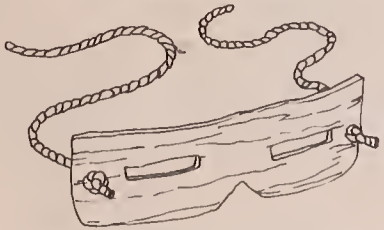
Glare protection

Snow blindness can be a serious problem when one spends any length of time in the winter environment. Extreme amounts of glare are produced by the sun's rays reflecting off the bright, white surface of the snow cover. The students can test the intensity of this glare by using a photographic light meter.

Tape the light meter about half way up a metre stick. Hold this apparatus above different surfaces such as open snow drifts, shaded snow drifts, pavement, sidewalks etc. Record the various findings and make a chart or graph to illustrate your findings.

Sun glasses or tinted goggles should always be worn on sunny days in the snow. If these are not available, there are several simple ways to make your own snow-goggles.

If you are in the classroom and have the materials available you can make snow goggles by cutting frames out of wood or cardboard. Cut slits in the frames and attach elastic or string to secure them as shown.



If you are in the forest and need to improvise, you can make the same kind of frames with bark. Almost anything can be used to make frames for sun-goggles. Trappers have even been known to use the leather tongues from their boots. Another simple method of cutting down glare is to rub charcoal under your eyes.

Also, it is wise to carry a good cream sunscreen to protect your skin against sunburn.

Snow survival kit

An interesting method of furthering the study of winter survival is to have the students discuss what should be included in a snow survival kit. After having tested the equipment they have discussed in a simulation exercise, they could use their findings to put a kit of the most appropriate items together. Their decisions might be aided by discussions on frost-bite, hypothermia and first-aid.

A good reference book is *Wilderness Survival,* put out by the B.C. Provincial Forest Service. A class set may be obtained by writing to the Forest Service, Parliament Buildings, Victoria, B.C.

Winter survival exercise*

The following is an exercise designed to help the students make logical decisions about what to include in their snow kit through simulation and discussion. Here is an example situation:

Due to some misfortune, you have been lost in a very densely forested area (mixed) which is 96 k from civilization in any direction. Fortunately you are properly experienced and prior to being lost, made a choice of SIX survival items. In the following list, choose SIX survival items, rank these items, and explain your reasons for choosing each one.

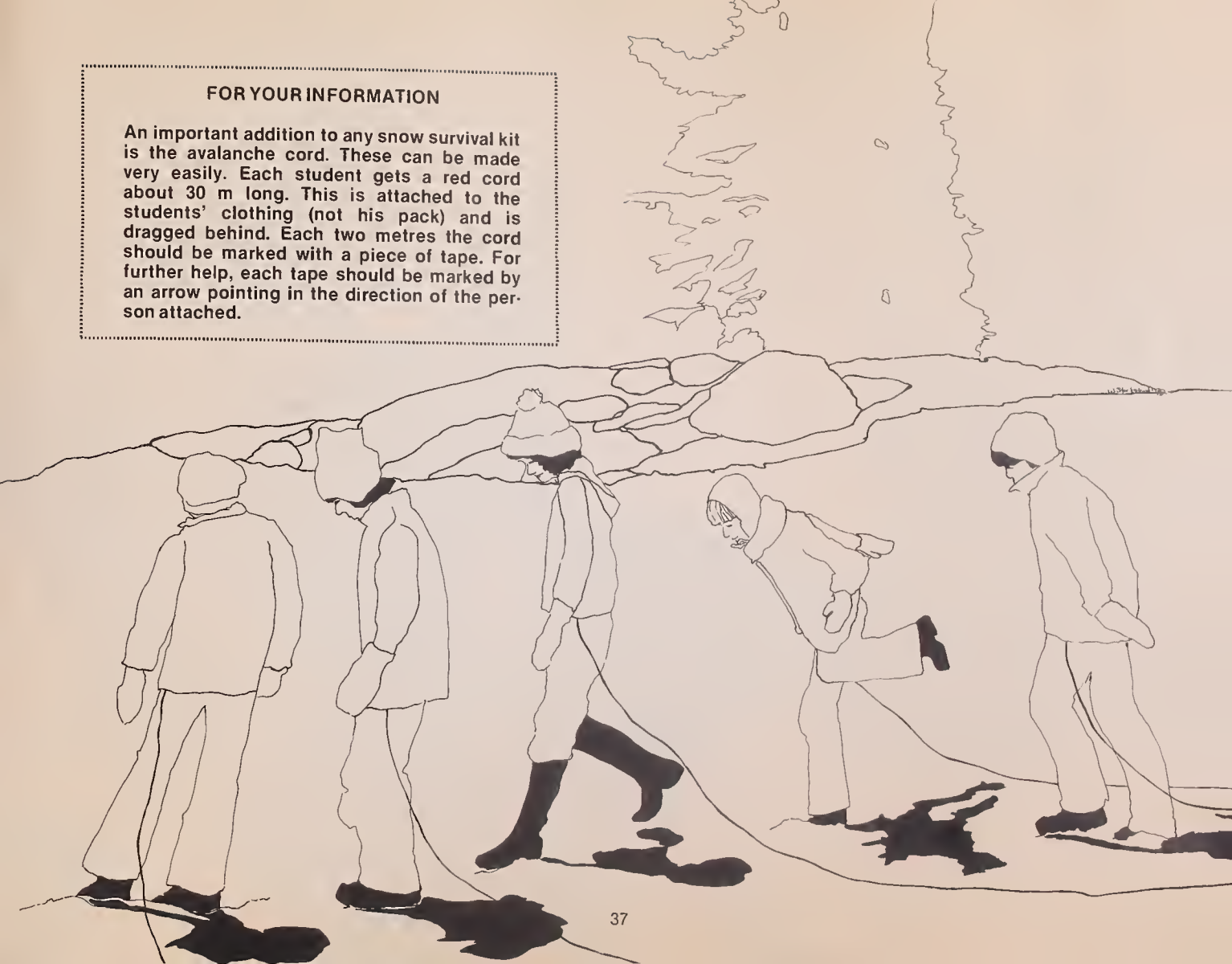
Survival items:

kindling wood	**string (20 m)**	**metal pot**
axe	**sunglasses**	**fishing line**
box of matches	**whistle**	**toboggan**
metal plate	**paper**	**compass**
fishing rod	**candle**	**kitchen fork**
snowshoes	**camp stove**	**icing sugar**
first aid kit	**rope (10 m)**	**hunting knife**
flare gun (2 flares)	**canteen of water**	**binoculars**
mirror	**cross country skis**	**wire (5 m)**
hand gun (4 bullets)	**extra pair of socks**	**sleeping bag (winter lined)**
book on winter survival	**dehydrated beans (5 cans)**	**battery operated handwarmer**
flashlight	**emergency code book**	**lighter fluid (cam)**

* Apapted from: Phillips, R.E. and C.A. Watson. 1977. *Winter Investigations: Teacher Resource Manual* Enviro-concerns, Manitoba.

FOR YOUR INFORMATION

An important addition to any snow survival kit is the avalanche cord. These can be made very easily. Each student gets a red cord about 30 m long. This is attached to the students' clothing (not his pack) and is dragged behind. Each two metres the cord should be marked with a piece of tape. For further help, each tape should be marked by an arrow pointing in the direction of the person attached.



PART FOUR

Snow Fun

This section includes a variety of activities designed to enhance children's learning by promoting winter enjoyment. The teacher may wish to add greater interest and excitement to many of the experiments by interspersing some of these activities throughout their study. These activities are also well adapted to helping the teachers integrate the study of snow with other subject areas.

An excellent project for the class or even the whole school could be developed by using these ideas as a framework for presenting a winter carnival. With the use of some imagination, the children could develop their carnival into a series of spectacular art displays, delicious snow recipes and original winter games.

Art Activities

Snow dioramas

Kids enjoy creating their own arctic scenes and much can be learned by making displays and models of the areas under study.

Use any size of cardboard box to create a winter diorama. These can be attractively lit from behind with electric lights, flashlights, candles, etc. Shoe-box dioramas are effective for miniature scenes which can be viewed through a small peep-hole through the end of the box.

Large hall display areas can be implemented to create attractive and accurate scenes which can be put together as a class project.

Snow sculpturing

This can be an interesting and informative activity for the students, especially if the teacher uses a theme related to what the class has been studying, i.e. animals, story-book characters, dinosaurs, famous figures.

An alternative activity is to have the class work as a whole on one huge "snow beast." All of the above sculptures could be coloured, using spray paint, food colouring, etc. Teachers should be aware, however, of the residue left after the snow melts. Most water-based paints are harmless and will disappear eventually.

Painting on the snow surface

Snow-painting is a good example of ephemeral art (in that it is non-lasting). You may use dry, wet or spray paint but as previously mentioned, these should be water based so they won't harm the environment when the snow melts. Have the children create ways of applying the paint such as sprinkling, dripping, blowing, squirting, etc. Their paintings may be made more permanent by slipping some thick construction paper under the snow surface to be painted. Areas for snow painting may be protected by roping them off.

Sketching

Many different techniques may be used to create effective winter landscape sketches. Chalk on black paper works well or for a negative image, white paper and charcoal can be used.

Frost drawings

Interesting and beautiful patterns can be created in the classroom or if it is cold enough out of doors. Simply steam up a piece of glass by holding it over a container of boiling water and then freezing the glass. Interesting patterns are formed as the water freezes. These patterns can be made permanent by tracing them on to paper with a fine tip pen and india ink. Some students may wish to photograph their designs.

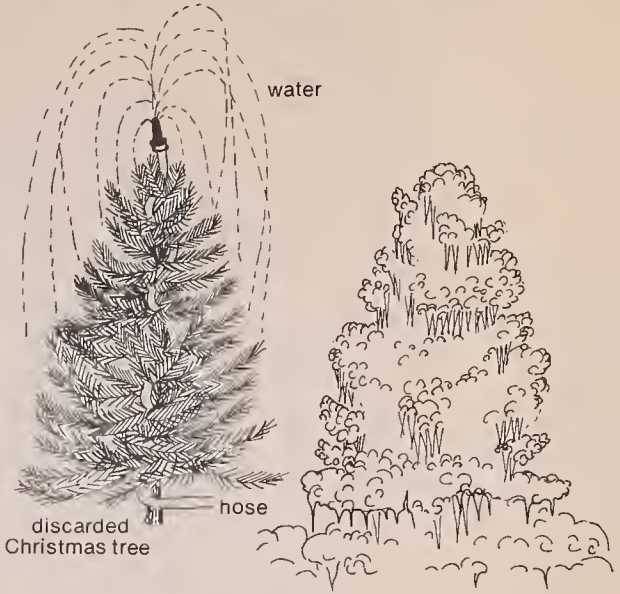
Photography

Photographs can be used to record any of the activities in this unit. Unique lighting conditions call for special attention to exposure, and the students will greatly benefit from taking pictures in the winter environment. Bright lighting and high contrasts facilitate the use of pin-hole cameras. See the WEDGE unit on pin-hole photography.*

* *Classroom Cameras*, WEDGE, University of B.C., 1974.

Ice trees

As a backdrop for a winter carnival or to enhance the effectiveness of the students' snow sculptures, ice trees may be made. Simply erect several discarded Christmas trees by attaching them to stakes in the ground. Attach a hose to the trunk facing upwards. When the water is turned on and ice forms, a beautiful fountain of ice will be the result.



More things to do

There are a myriad of art activities that can be carried out in the winter environment. The students should be encouraged to come up with their own ideas. Some areas of interest are:

snow posters
snow bulletin boards
plaster models of snow landscape and snow shelters
toothpick snow flakes (paint them white and glue them together)
folded paper snowflakes
snow parade (decorated sleds, toboggans, etc.)

Frozen Recipes

Apple snow

You will need:
- 550 mL can of apple juice
- 15 g sugar
- 2 mL lemon juice
- 2 mL grated lemon rind
- large bowl and spoon
- metal pan (about 20 × 20 × 5 cm)

Combine all ingredients, stirring until sugar is dissolved. Pour into metal pan and freeze until firm. Scrape off hard frozen mixture with the edge of a spoon to make "snow" at serving time. Spoon into serving glasses. (Serves 4)

Homemade ice cream

You will need:
- 2 bowls
- an electric or hand beater
- a freezer tray
- 250 mL mashed fruit (fresh or drained canned fruit)
- 125 g sugar
- 250 mL whipping cream

Mix the mashed fruit with the sugar in one bowl. In the second bowl, beat the whipping cream for 3 to 4 min. Fold the whipped cream carefully into the fruit mixture and put in the freezer. Remove the mixture from the freezer after about 1.5 h. It should be frozen around the edges and on top. Now beat the ice cream, until the frozen edges mix into the rest and the whole thing becomes mushy. Replace this mixture into the freezer for 3 h and the ice cream will be ready to eat!

Lemon Sherbert

You will need:
- 150 g sugar
- 125 mL lemon juice
- 500 mL milk

Add all your ingredients to a large bowl and beat together. Pour this mixture into a flat tray and freeze for about 3 h. Remove from the freezer, beat the half frozen mixture and freeze for another 3 h.

Frozen Yogurt

You will need:
- 1 large container of yogurt
- mashed fruit of your choice

Combine the mashed fruit with the yogurt and pour into a flat pan. Place this mixture into the freezer for about 1.5 h. Remove the half-frozen yogurt from the freezer and beat. Replace in the freezer. Your frozen yogurt will be ready after 1.5 h.

Baked Alaska

You will need:
- a white sponge cake
- 0.5 L of ice cream (any flavor)
- 4 eggs
- 16 g sugar
- hand or electric beater
- a baking sheet
- a large bowl
- a small, flat metal pan

Preheat the oven to 200°C.

Start the meringue by separating the whites of 4 eggs. Beat these egg whites until they reach the texture of whipped cream. Slowly add the sugar and beat well for about 5 min. The meringue is ready when it becomes stiff and shiny. Place the sponge cake on the baking sheet. Flip the ice cream on to the top of the cake. Spread the meringue evenly over the ice cream and cake until they are completely covered with a 2 cm layer. Put this cake into the pre-heated oven for about 3 to 5 min, until the meringue begins to turn brown. Serve immediately.

This is an excellent opportunity to demonstrate the insulation value of meringue.

Snow Games

Dog sled races

Using students as dog teams, time trials can be run on a designated course. Allow the students to come up with their own creative sleds. This will give them some insight into the sliding properties of snow, and will motivate them to find out what kinds of materials work best on varying types of snow cover.

Reindeer hunt

Objects representing reindeer are spread out on the side of a hill. The students slide down the hill on their sleds or toboggans, trying to collect as many objects as possible. Other types of sledding activities can be improvised by the students such as:

greatest speed
greatest distance, etc.

Snow puzzlers

This activity takes some preparation because photographs must be taken of various objects that have been covered by snow. These should be made as interesting as possible so students will want to guess what is under the snow cover. This is a good introduction to the drifting properties of snow. The teacher should allow the students to take their own photographs to test out on the class.

Eskimo football

Age: Intermediate
Players: unlimited; two groups
Place: playground
Supplies: football

The playing area for the game is the space between two long parallel lines. The distance between the lines depends upon the number and the ability of the players. The eskimo boys scratch the lines on the ice or hard dry snow. The players divide into two teams. Each team stands on a line and faces the center of the field. The umpire stands midway and at one end of the space between the lines. He starts the ball rolling slowly between the teams. As the ball stops rolling, the umpire calls, "Ai," which is the signal for the teams to rush forward and kick the ball across the opponents' line. The winner is the successful team.

In a variation of this game the two teams stand 3 m apart within the playing area. The players form a compact wall by standing very close together. The umpire throws the ball down between the teams. As a unit the teams rush forward to kick the ball. If the ball is kicked through the wall of players, the teams quickly break ranks. The defensive team tries to keep the ball from crossing the line in the rear. The offensive team tries to score by kicking the ball over the line.*

Ha-Goo (Come on)

Age: Intermediate
Players: unlimited; two groups
Place: gymnasium; playground
Supplies: a brightly coloured banner

This game is popular with the Thlinget (pronounced Klinket) children in southeastern Alaska.

Two parallel lines 10 m apart are drawn on the ground. The players are grouped in two sides and stand on the lines facing their opponents. A captain is appointed for each side. The captain of one side signals with his banner (a rag fastened to a stick) and cries "Ha-goo" or "Come on." One player from the opposite side advances while his opponents try to make him smile by saying funny things or making funny faces. If the player smiles the least bit, he is out of the game and another player is sent out from his side. If he crosses to the opposite side without smiling, he has captured the banner and returns with it to his side. The play continues until all players except one have been eliminated. The object of the game is to hold the banner last.*

Tracking games

These games are only suggestions and it should be left up to the students to provide their own rules and regulations.

— Play tag, stepping only in others' foot prints.
— Set up courses for students to follow each others' tracks. These could be timed and recorded.
— Have a snow track scavenger hunt, where the students have to find and identify a particular list of tracks.
— The winter environment is perfect for teaching compass work and orienteering. See the bibliography for references.

* Adapted from: Hunt, Sarah and Caln, Ethel. 1950. *Games Around the World,* A.S. Barnes and Company, New York.

Eskimo snow terms game

The following is a list of Eskimo terminology which refers to snow conditions. The purpose of including this list is to allow the students to make up games to play. These may be in the form of scavenger hunts, codes, or even board or card games.

KOBUK VALLEY ESKIMO TERMINOLOGY*

Term	Pronunciation	Meaning
anniu	(an-nee-you)	falling snow
api	(aye-pee)	ground snow
qali	(kall-ee)	snow on the boughs of trees
qamaniq	(com-an-nique)	bowl-like depression at the base of a tree
siqoqtoaq	(see-cok-tow-ak)	sun crust
siqoq	(see-cok)	smoky snow
anamana	(unya-munya)	space formed between drift and obstruction
upsik	(up-sik)	wind beaten snow
mapsuk	(map-sook)	overhanging drifts
kaioglaw	(kay-oh-glak)	sharply etched wind eroded snow surface
tumarinyiq	(too-mah-rin-nique)	ripple type drift
kalutoganiq	(kal-oot-ah-gon-nique)	arrow-shape drift
kimoaqtruk	(kee-mow-ak-rook)	snow drift
pukak	(pew-cak)	bottom snow layer
aute-sheni	(aut-doe-shen-nee)	ventilation shaft
quin-zhee	(quin-gee)	temporary snow shelter

More things to do

Any activities that are not normally played in the snow, take on new and interesting properties.

— golf
— soccer
— baseball
— hockey
— football
— frisbee
— dodge ball
— hide and seek

* Taken From: Phillips, R.E. and C.A. Watson. *Winter Investigations: Teachers Resource Manual,* Enviro-Concerns, Winnipeg. 1977.

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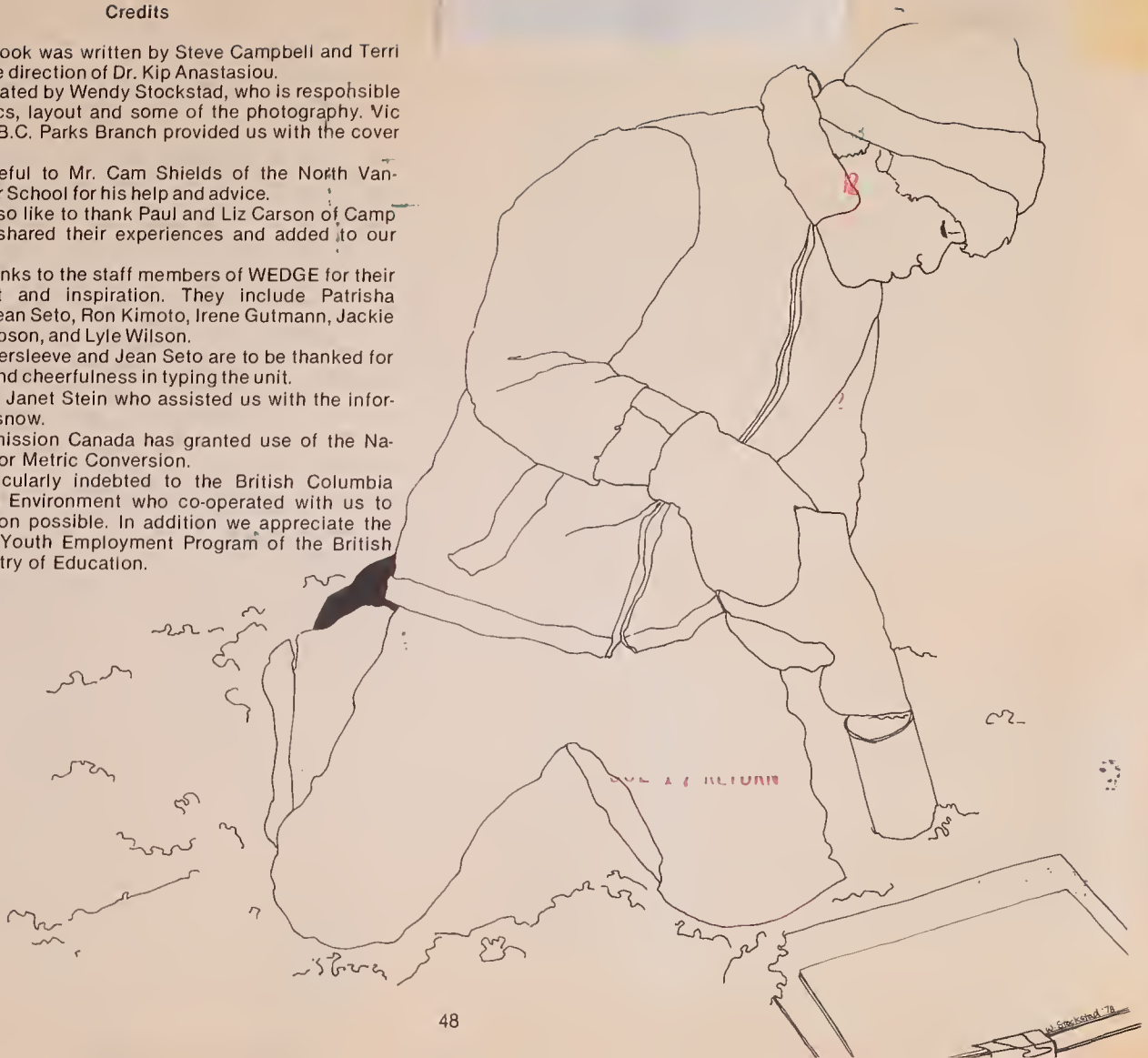

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